POWER

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ELY C. HUTCHINSON, *Editor*

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Two Letters

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HERE are a couple of letters. The second is not offered as a solution for the difficulties of the writer of the first. They happened to come in at about the same time.

Although it is true, by and large, that there are more jobs and better jobs, more money being paid to power plant engineers, and larger opportunities open to them than ever before, it is also a fact that many cases of such hardship have been occasioned by the centralization of power generation.

When one has grown up with a plant, adapted himself to it, qualified himself to handle it efficiently and effectively, regards it as his accredited sphere of action, and has reason to feel established and satisfied with himself, it is tragic to have the ground cut out from under him in this way.

And although his attainments may be such as to qualify him for a position of real responsibility, it is difficult for one who has been, as many engineers are, somewhat of a recluse and whose knowledge and practice are special to the plant that he has been running to connect with the distant situation where he could be used to advantage. It is a pleasure when *Power* can be useful in helping to establish such a connection.

That man will stand the best chance who has the wide acquaintanceship and knowledge, experience and ability that the few possess. The chances now are for men who are capable of managing plants rather than for those who simply run engines.

F. R. Low

Perhaps the editors of *Power* wonder why old subscribers drop off their list. I am among those who have been reduced to the status of a fireman by the distribution of electric power. I no longer need the service of *Power*, and no longer can I afford the $3 a year for it. If I am to improve my condition in life it cannot be done by reading *Power*. I must get the ashes out of my hair and turn to some other kind of work. No intelligent steam engineer should have a feeling of enmity toward centralized power, but the problem of the displaced man is to avoid being forced down to the position of the laborer who has no qualification except his power to do horse work.

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When I enrolled for a course in fuel and combustion engineering I was 55 years old. I realized that I had not done very much in life and that things were getting harder for me every day. I didn't know whether I was too old to start the course, but I still had a little ambition left and decided to try it out. I talked to some of the younger men around the plant about it and every one of them laughed at me for tackling a proposition of this kind, because of being too old. You know how it hurts a man when he gets around 50 to be called old, but I believe that some of us are no older than a fellow 30 years of age who will not try and do something and help himself to get ahead.

I made up my mind to go ahead with the course. I did, and have completed it. During the past year my salary has been increased a little better than 50 per cent. In that way the course has been paid for many times over. I have a better job, and now instead of the younger fellows laughing at me it is my turn to laugh at them. After all, a man is just as old as he wants to make himself appear.

EDITORIALS

More Power to the Oil Engine

"EVERY dog has his day."—Students of the subject see a rift in the cloud that has so long obscured the way of the oil engine. To say the least, except for a few special applications, the industry at home, and also to a somewhat lesser extent abroad, has been in the doldrums.

In the past, the best market has been in marine service, where economy of space and operating labor, simplicity of fuel storage, high load factor, and other general conditions of operation have been in the oil engine's favor.

On the other hand, extended application ashore has been slow. Its use as a community or isolated power producer has been circumscribed by the readiness with which the public utilities would extend their service to new markets. As a power unit for many localities it has had to meet the retarding effect of high-priced fuel.

Paradoxically, the slowest advance in the use of oil engines has been in the larger sizes, because no way has been found to economically make them larger. But, given a reasonable fuel cost and large capacities at moderate weight and cost per unit of power, the oil engine will find a far greater field of usefulness.

Considering all these things, and if there is anything in signs, the day of the oil engine is not far off.

Speaking generally, many of the electric power companies have reached out for their markets to the point where they are now facing their economic limit. Further extensions will cost more in service than the load will pay.

Meanwhile the country-wide growth in the use of natural gas and its adoption in industrial service will release vast quantities of fuel oil, a market for which must be sought elsewhere. Under such pressure, oil engine fuel is certain to find its way to new places at commercially usable prices.

Then too, consider the increased power per unit of weight that the double-acting oil engine has introduced.

In addition to this, the employment of gas turbines utilizing the exhaust gases to operate superchargers, has brought about an eighty per cent increase in power output per engine cylinder.

Late engine designs are successfully using higher piston speeds, and in Europe Diesel engines are being built with a weight of only twenty pounds per horsepower.

At present the fifteen-thousand-horsepower engines operating in Hamburg are the largest, but with the great improvements now in process it is apparent that the day of higher-powered and less-expensive oil engines is not distant.

With these important elements in their favor, the course of the oil engine's progress appears to be well charted.

Engineering But No Engineers

THERE is no criticism of the personnel of the commission recently named by Governor Roosevelt of New York to formulate a plan for hydro development on the St. Lawrence River. It includes an economist of recognized standing, a banker, a former Lieutenant Governor of the state, a professor of law who is a deep student of government, and the counsel to the Port Authority. The scope of the problem will bring to bear the experience and best thought of these men.

But how about the many engineering questions involved, for which as yet there is no engineer on the commission.

It may be argued that surveys have already been made by competent engineers and that these are available to the commission. Quite true, but it would seem very essential to have an engineer on the commission to interpret these reports in the light of engineering econom-

ics. It has been announced that, engineers will be called upon to advise the commission, but this is a poor substitute for one who could confer in an executive capacity.

The case is analogous to the appointment of a sanitation commission without representation from the medical profession—a procedure that would incur instant public disapproval.

Is it not possible that some of the engineering societies have been asleep to this opportunity for public service, where so much engineering is involved and where a misinterpretation of facts may commit the state to economic blunder?

Waterwheel and Plant Efficiencies

THERE are just as many opportunities for losses in water-power plants as in steam stations. In hydro-electric, as in the steam plants, many of the losses are not plainly apparent and may exist unknown until conditions become so bad that the unit fails to develop full power. Losses of five to fifteen per cent may exist without detection unless operating tests are made. Trash on the bottoms of racks, growths on the inside of penstocks, obstruction against the wicket gates, worn and eroded parts—none of them are evident from a superficial inspection, but all cause losses in efficiency.

A more insidious loss may occur when operating two or more units of different characteristics in parallel. A division of the load between units, proportional to their capacities, is not always the most efficient. The allocation of load is a function of the efficiency curves of the respective units. The proper system of loading a group of units can be determined only by tests, from which a loading schedule should be worked out. Where the load fluctuates through wide ranges, automatic means for making the load division between units may be required to obtain best results.

Of equal importance to proper loading of the units is knowledge of how their efficiency is affected by service. Some machines operate for long periods with very little wear, while others deteriorate more rapidly. Some wheels suffer a pronounced decrease in efficiency as they become worn, and hydro plant operators have found it economical to provide means for a continuous check.

The efficiency of modern waterwheels is now about as high as may be expected. But with certain designs of wheels there will probably be improvement at small loads and overloads. Granted that the efficiency of waterwheels cannot be materially bettered, many plant operators still have within their reach the possibility of improving plant efficiencies by intelligent maintenance and operation. It is less important to look for the small gains possible in waterwheel efficiencies when plant efficiencies are ten per cent or more below those possible with better operating methods.

A Comeback for Turbine Drive

SOME power engineers who have studied the problem are predicting increasing use of steam turbines for auxiliary drive. In this connection it is worth while to review the factors which originally led away from turbines to motors and to see wherein changed conditions might again favor the turbine. When electric drive came into favor about eight or ten years ago its advocates pointed to the elimination of much piping, with resulting improved appearance of the plant. This advantage of the motor still stands.

Another original argument for electric drive was improved station efficiency. The adoption of bleeder heating made turbine exhaust for feed heating unnecessary. At the same time the great discrepancy between the efficiency of main units and small auxiliary turbines meant that a motor took less net fuel to deliver a given amount of power to the auxiliary shaft even with the losses in the generator, motor, and transmission.

This argument has less weight than formerly. Increased size of boiler units has greatly increased the power required for individual auxiliary drives. This, together with improved design and construction of auxiliary turbines, has resulted in a notable increase in efficiency. In fact, the margin has been cut in many cases to a point where the auxiliary turbine practically holds its own with the electric motor on a basis of plant efficiency after allowing for the associated electrical losses that handicap the motor drive.

The expense and difficulty of obtaining satisfactory speed control of alternating-current motors driving fans, pumps, and other auxiliaries is another factor always present, and now more generally recognized. A new and related influence is the growing acceptance of automatic centralized plant control. In many cases the installation of such control is made considerably cheaper by the use of turbines to drive certain auxiliaries.

The central heating business is on the upgrade. It is obvious that heating plants, ordinarily lacking in main generating units, offer a particularly inviting field for turbine drive.

Actual data on the relative position of turbine auxiliary drive at the present time are lacking, but the prosperous condition of certain companies making equipment of this type would indicate that this trend in thought is reflected to some extent in actual station design.

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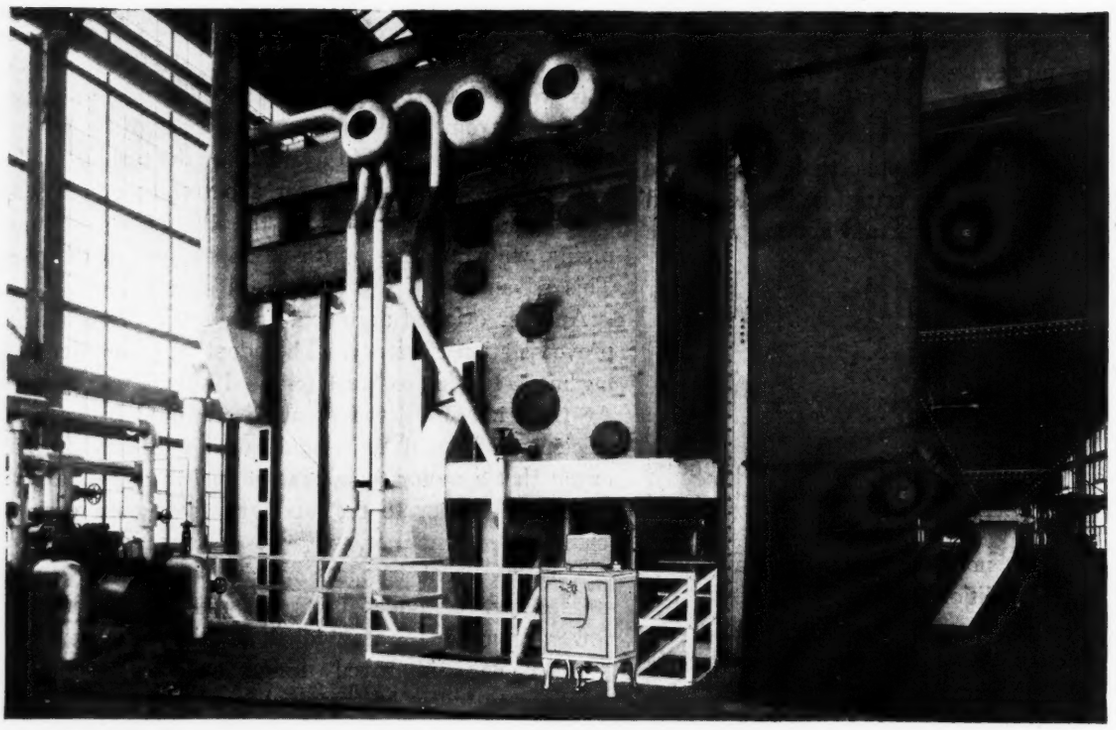
1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

Two Men Run It!



Plenty of glass, free use of aluminum paint, and electrically refrigerated drinking water make operation a cheerful job

CENTRAL CONTROL—LIGHT—AIR SIMPLIFY STEAM GENERATION

for General Steel Castings

By P. W. SWAIN
Associate Editor of POWER

AT EDDYSTONE, PA., near Philadelphia, stands the new $13,000,000 plant of the General Steel Castings Corporation. The Eddystone plant, in operation only since July of this year, is the last word in steel foundries. Nowhere else have arrangements for handling sand, molten metal, patterns, and castings been so carefully worked out in every detail. In no other steel foundry has such attention been given to the power service systems to insure maximum effectiveness with economy of operation.

The plant occupies a huge plot of land bordering the Delaware River. There is ample room for growth as the business expands. Ocean steamers can dock directly at the plant to load up with castings, whose individual weights may range from 20 to 150,000 pounds.

The power service arrangements reflect the same modern spirit as is embodied in the production layout and equipment. A story of great interest could be built around the two large substations wherein current purchased at 13,000 volts is transformed and converted to supply the foundries, machine shop, and other departments with direct and alternating current at the desired voltages. Another valuable story could deal with the elaborate distributing system that insures reliable electrical service to great cranes, machine tools, and material-handling equipment. Another could be found in the air compressors and air-distributing systems. All of these services, up to the actual points of manufacturing application, are under the direct supervision of the power engineer, who, in turn, reports to the chief engineer of the works.

This article, however, is concerned primarily with the boiler house, which might well serve as an industrial model. It supplies steam to heat the enormous manufacturing buildings in winter. One of these is 1,200 ft. in length and another 1,000 ft. Both in summer and winter steam is supplied for special process uses, chiefly the atomization of fuel oil to fire open-hearth furnaces, core ovens, and annealing furnaces.

The heating load far exceeds the process load, so that the winter steam peak of 1,500,000 lb. per day drops to around 340,000 lb. in the summer. This calls for a plant

of great flexibility with boilers that will operate steadily and efficiently at high ratings in the winter and work satisfactorily at a fraction of normal rating in the summer.

Two things immediately impress the visitor to the boiler house. One is the general shipshape appearance, and the other is the fact that the normal operating force consists of exactly two men—a shift engineer and a helper. No other labor or supervision is required beyond an occasional visit by the power engineer, whose office is a quarter of a mile away in the combined compressor room and substation, and help as needed from the general repair and maintenance gangs of the manufacturing plant.

With a normal force of two men the plant is a model of good operation, and the staff finds ample time for all necessary work, including regular testing of the feed water at two-hour intervals.

Several design features make this possible. First, the entire plant may be controlled from a single location. Except for the starting and stopping of coal- and ash-handling equipment, all normal operations—starting and stopping of machines, speed control, etc.—are controlled by push buttons and regulators on the central control board or by handwheels directly in front of it. On the same board are indicated or recorded all plant data needed for intelligent operation.

Other factors making for ease of operation are extreme visibility, accessibility, cleanliness, and other provisions for the comfort and effectiveness of the operating force. Very high walls, three-quarters glass on two sides and half glass on the others, admit a flood of light. Illumination is further improved by the aluminum paint which has been applied to all exposed steel work and also to the canvas jackets of pipe insulation and boiler-drum lagging. A gypsum-block roof retards penetration of the sun's heat. Very large electrically raised doors at the two ends of the boiler house insure cooling breezes in summer. As a final touch of luxury the men are provided with an electrically refrigerated drinking fountain and a modern shower bath.

With the occasional glimpse of a yacht on the Delaware River, one might almost mistake the place for a summer resort. Certainly its coolness and cleanliness on a hot summer day were strikingly evident at the time of the writer's visit.

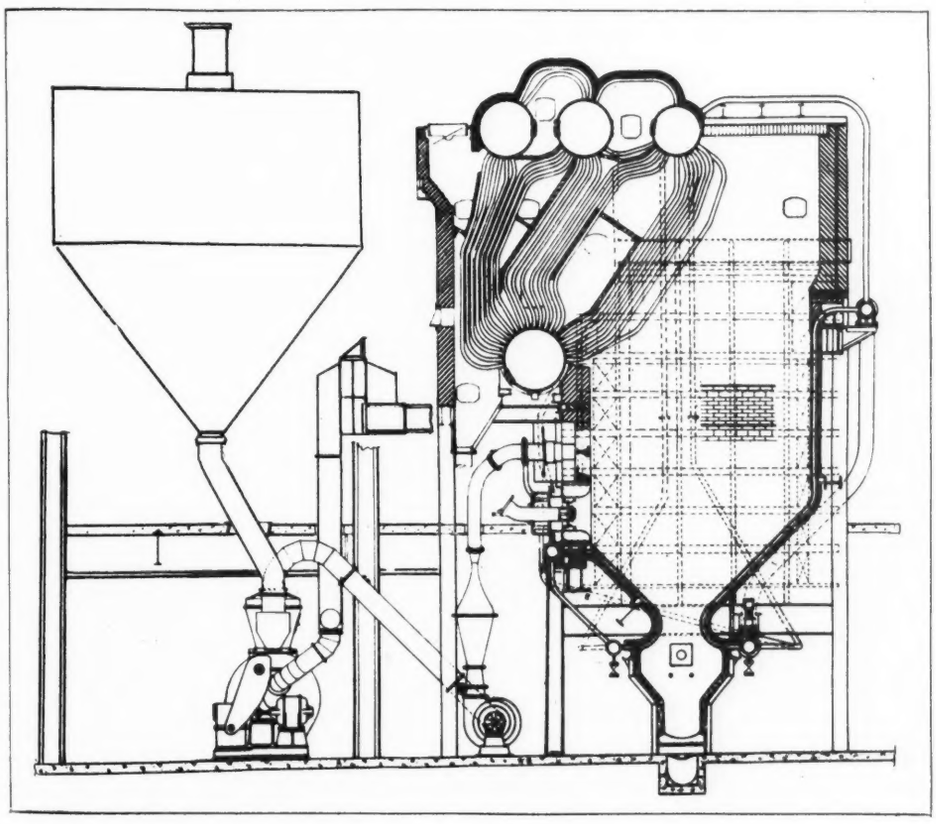
Welded steel stairways, guarded by ample railings and non-slip treads, give easy access to all operating levels. Liberal use of grating floors prevents interference with light.

All of these features undoubtedly contribute to operating morale, and, hence, to fuel economy, reliable operation, and effective upkeep. Heavy labor is practically eliminated by complete mechanical coal handling, pulverized-coal firing, and hydraulic ash sluicing.

The boiler plant equipment is listed in some detail at the end of this article. Much of this is also shown in the accompanying photographs, which do not, however, give an adequate idea of the spaciousness and accessibility of the plant. The following description will outline but briefly the major equipment, with comments on matters of special interest.

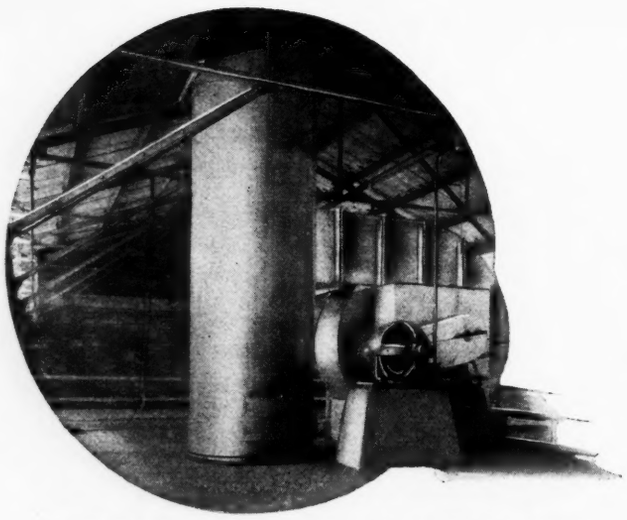
Steam is furnished by two 7,092-sq. ft. boilers with space for a third unit. They are of the inclined water-tube type, designed for 200 lb. pressure but normally operated in the range from 125 to 150 pounds.

Firing is from the back, with two burners per boiler for normal operation. Each boiler has its own unit mill. In addition, a third small mill to supply either boiler through a third burner for the light summer load has been installed. The maximum plant load in summer reaches 16,000 lb. of steam per hour, requiring the operation of one boiler at 70 per cent of rating. As the manufacturing plant grows, a third boiler unit will be installed in space already provided. The average summer load of 12,000 lb. per hour requires a rating between 50 and 60 per cent on a single boiler.



Pulverized coal is fired from the back of the furnaces. Front and back are water-cooled, sides are air-cooled

A combination of water walls and air-cooled walls provides suitable protection for high ratings without overcooling of the flame. The furnace is fired from the back, with water-cooled walls front and back. Air admitted to the sectionally supported side walls goes to the mill as required. Air stacks from the walls to the top of the boiler room insure an ample flow of air at all times and carry away the excess not delivered to the mills. All plant auxiliaries are motor driven with the exception of the feed pumps, which are duplex reciprocating units. Induction motors, 440-volt, are used throughout except for the induced-draft fans, which are driven by direct-current motors with drum-switch speed



Induced-draft fans are driven by direct-current motors controlled from the operating floor

control. Coal and ash handling is entirely mechanical. Coal is carried by a flight conveyor from the track hopper to a hammer-type crusher and reduced to $\frac{3}{4}$ in. It is then elevated from the basement to a belt conveyor distributing to overhead bunkers. This equipment may be operated by push button from the basement and also from a point above the bunkers. Interlocking devices insure proper sequence in starting and stopping.

Coal for each boiler is pulverized by a single unit mill whose capacity ranges from 1,500 lb. to 8,000 lb. per hour. A third small mill arranged to supply either boiler for summer loads has a capacity of 750 to 3,000 lb. per hour. The pulverizers, as already indicated, draw preheated primary air from the side walls of the furnaces. Control of mills and exhauster fans is by push buttons.

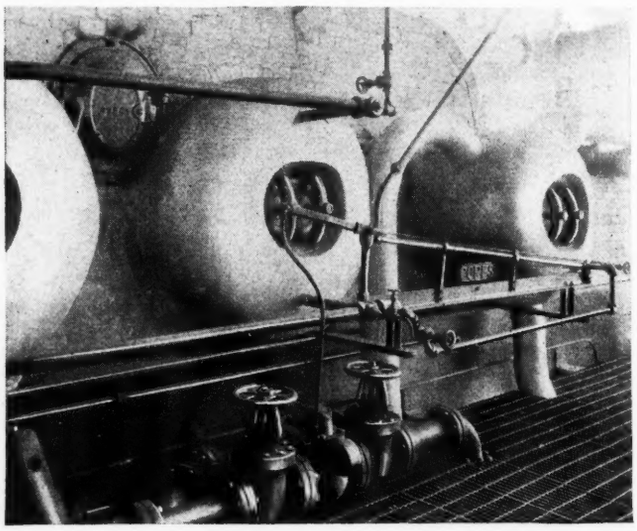
Hydraulic sluicing of ashes contributes largely to the general cleanliness of the plant and simplifies operation. Fly ash from the third pass of the boiler runs by gravity to the sluiceway. Ash and water are discharged to a sandy pit near the plant. This drains rapidly, and at the present rate will take years to fill up with ash. Sluicing water is furnished by a 250-ft.-head centrifugal pump driven by a 100-hp. motor.

Draft for each boiler is furnished by an induced-draft fan driven by a 220-volt direct-current motor, whose speed can be controlled from the central board.

Operation of the entire boiler house is centered on and around this control board

The total make-up water is practically constant the year round and represents the amount of steam delivered to process. Only the building heating condensate is returned. This make-up, which amounts to about 10 per cent in winter and nearly 100 per cent in summer, is Delaware River water first heated to about 140 deg. F. in cooling the fronts of open-hearth furnaces.

Make-up and condensate are collected in adjacent sumps arranged for cross-connection in case of failure of either pump. Condensate and make-up are pumped to separate compartments of an open deaërating heater placed above the settling tank of a hot-process lime-and-soda softener. The heated condensate passes directly to a feed storage tank within the settling tank. The raw



Exposed ends of boiler drums are kept white with aluminum paint

make-up, after addition of chemicals, passes to the settling tank and then to a sand filter, from which it is pumped into the storage tank.

Chemical proportioning is controlled by alkalinity tests, which are made by the shift engineer at two-hour intervals.

Feed water is delivered to the boilers by two double-acting, duplex, outside-packed plunger pumps. Extra heavy piping with Van Stone flanges and 85 per cent magnesia insulation is used for all feed and steam piping.

The recording, indicating, and control apparatus on the central control board is detailed in the table of equipment. It will be seen that the instruments listed give readings of steam pressure, draft at 5 points, CO_2, feed-water pressure and temperature, city water pressure, and boiler output. A temperature recorder on the blowdown tank gives a definite check on the frequency and duration of blowdown. On the same board are induced-draft fan rheostats and push buttons for starting and stopping pulverizing mills, exhauster fans, etc. Near the board are drum-type controllers for the exhauster fans, and handwheels controlling the mill feed.

Although this article is concerned primarily with the boiler house, a

Principal New Power Equipment Installed

General

Location .....Eddystone, Pa. (Near Philadelphia)
Designed and constructed by.....General Steel Castings Corp.
Chief Engineer .....W. R. Chambers
Power Engineer .....Earl C. Metzger
Went into operation .....March 8, 1930

Building

Dimensions, ft., 60x120x57 high to bottom of roof truss
Construction:.....Steel frame; south and east walls three-quarter glass; north and west walls one-half glass; ventilating skylights; concrete tile roof; floors concrete and Irving subway grating; all exposed steel work and heat insulation aluminum painted.
Service....Saturated steam for heating, oil pumping, furnace operation, etc.

Boilers and Furnaces

Number: Installed, 2; ultimate.....3
Type and make, Stirling water-tube.....Babcock & Wilcox Co.
Water-cooled hopper bottoms: Bailey.....Fuller Lehigh Co.
Total heating surface per unit, sq.ft.....7,197
Water-wall heating surface, front, sq.ft.....308
Water-wall heating surface, back sq.ft.....812
Furnace volume, cu.ft.....4,600
Pressure (designed for 200 lb.), operating at.....125-150 lb.
Furnaces: Fired from back by pulverized coal; water-cooled front and back; air-cooled side walls by....American Arch Co.

Boiler Equipment

Feed regulators, Copes.....Northern Equipment Co.
Blowoff valves, Yarway, tandem.....Yarnall Waring Co.
Safety valves, 4 per boiler...Consolidated, Ashcroft, Hancock Co.
Water columns, inclined.....Yarnall-Waring Co.
Non-return valves .....Golden Anderson Co.
Stop valves (steam), balanced double disk.Chapman Valve Mfg. Co.

Coal Handling and Preparation

Track Hopper.....Jeffry Mfg. Co.
Conveyor to crusher, inclined, flight-type.....Jeffry Mfg. Co.
Coal crusher: Rigid-hammer type, 36x24 in....Jeffry Mfg. Co.
Drive, 440 volt, 10 hp. induction motor through belt, chains and gears .....General Electric Co.
Coal conveyor over bunkers.....Jeffry Mfg. Co.
Drive: 440 volt, 10 hp. induction motor.....General Electric Co.
Coal conveyor over bunkers.....Jeffry Mfg. Co.
Control of coal-preparation equipment: 3 push buttons near crusher. Duplicate buttons above bunkers..Rowan Controller Co. (Westinghouse safety switches)

Pulverizing and Firing Equipment

Main pulverizing units, 2 (1 per boiler).....Fuller Lehigh Co.
No. 6 Fuller Bonnot unit mill, 1,500-6,000 lb. per hr. capacity; drive, 440-volt, 50 hp., induction motor....General Electric Co.
Lehigh exhauster, drive, 440-volt, 25-hp., induction motor General Electric Co.
Summer-load unit: Similar to above but with capacity of 500 to 3,000 lb. per hr.
Burners, 2 per boiler, with third for summer load, Bailey-Tenney circular type.....Fuller Lehigh Co.
Firing: Horizontal from back of furnace.
Ignition: City gas.

Ash-Handling Equipment

System, hydraulic sluicing
Sluiceway and jets.....Allen-Sherman-Hoff Co.
Fly-ash handling: Delivered to sluiceway by chute from third boiler pass with compressed-air booster.
Sluicing pump, centrifugal, 100-hp., 250-ft. head., Dean Hill Pump Co.
Drive: 440 volt, 100 hp., induction motor...General Electric Co.
Gate valves.....Chapman Valve Mfg. Co.
Quick-acting valves .....Crane Co.
Ash discharge: To pit on sandy soil near plant.

Draft System

Primary air: From air-cooled side walls through steam pre-heaters to pulverizers.
Secondary air: Drawn in around burners.
Induced-draft fans, 2 (1 per boiler)..Green Fuel Economizer Co.
Drive, 220-volt, 50-hp., direct-current motor, through chains General Electric Co.
Control, from boiler room operating board..Rowan Controller Co.
Stacks, 2 (1 per boiler), steel, unlined, supported on building steel work above boilers.

Feed-Water System

Make up: Winter, about 10 per cent; summer, nearly 100 per cent.
Source of returns: Heating system condensate.
Source of make-up: Delaware River water supplied at 140 deg. F. after use for cooling open-hearth furnace fronts.
Sumps, 2 (1 for raw water and 1 for condensate).
Sump pumps, 2 centrifugal.....Weil Pump Co.
Drive, 440-volt, 15-hp. induction motor...General Electric Co.
Control: .....Push button
Feed pumps, 2, double-acting, duplex, outside-packed plunger pumps, 14x8½x15 in.....Worthington Pump & Machinery Corp.
Regulators .....Fisher Governor Co.
Feed treating and heating system.....Cochrane Corp.
Type: Hot-process (lime-soda); chemical proportioner; two-compartment open heater (raw water and condensate); treating and settling tank; feed storage tank (within settling tank); sand filter.

Blowdown System

Blowdown valves on boiler (See boiler equipment)
Blowdown valves of water walls, Yarway tandem, Yarnell Waring Co.
Blowdown tank.....Built locally to order

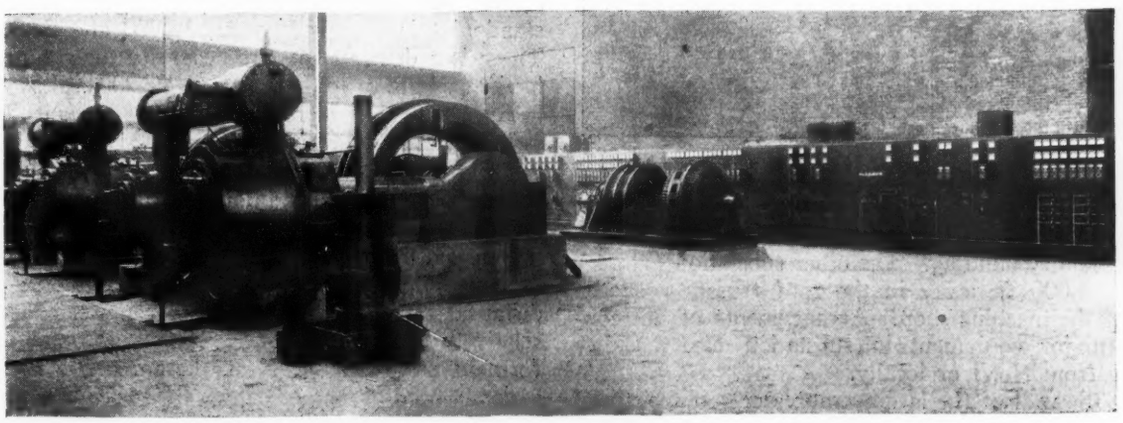
Miscellaneous Piping and Valves

Globe valves throughout.....Crane Co.
Gate valves throughout.....Chapman Valve Mfg. Co.
Steam piping, extra-heavy with Van Stone flanges.
Feed piping, Extra-heavy with Van Stone flanges.
Make of piping.....Midwest Piping & Supply Co.
Pipe insulation, 85 per cent magnesia.....Johns-Manville

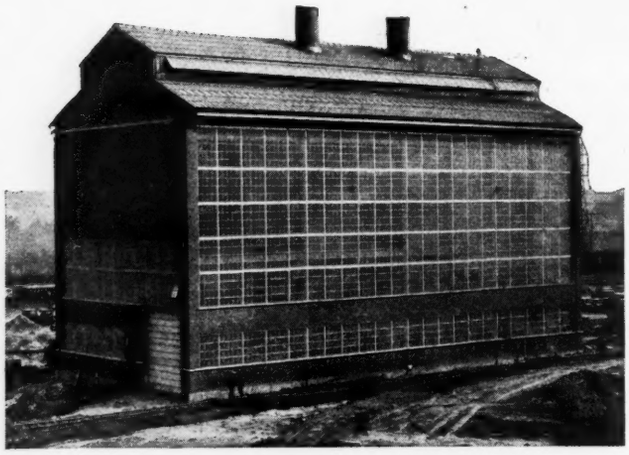
Central Control Board Equipment

Master pilot steam gage; one, 95-155 lb.....Ashton Valve Co.
Draft gages, 2, five-point.....Bailey Meter Co.
Stack temperature recorders, 2.....Foxboro Co.
Feed-water pressure recorder, 1.....Foxboro Co.
Feed-water temperature recorder, 1.....Foxboro Co.
Steam pressure recorder, 1.....Foxboro Co.
Blowdown tank temperature recorder, 1.....Foxboro Co.
City water pressure recorder, 1.....Foxboro Co.
Clock, 1 .....Foxboro Co.
Boiler output recorder, 1.....Republic Flow Meters Co.
Boiler output integrator.....Republic Flow Meters Co.
Boiler output indicator.....Republic Flow Meters Co.
CO_2 recorders, 2.....Republic Flow Meters Co.
Induced-draft fan controllers, 2.....Rowan Controller Co.
Push button controls.....Rowan Controller Co.

Two sets, as follows, for coal prepartion on main pulverizers: 1 spare, 1 induced-draft fan, 1 exhauster, 1 mill motor. Similar set for small pulverizing unit.



Motor-generator sets and two large air compressors are installed in the main substation



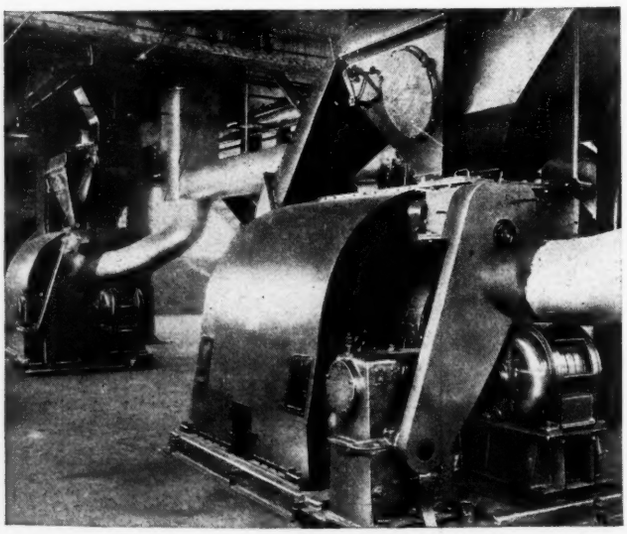
The boiler room is practically a "house of glass," but the gypsum-block roof and ample ventilation keep it cool in the hottest weather

word should be said about the other power equipment installed.

All current used is purchased from the Philadelphia Electric Company at 13,200 volts, 60 cycles.

Considerable quantities of compressed air are required by various foundry and machine shop operations. The supply is furnished by two large compressors. These are 3,800-cu.ft. per minute machines, delivering air at 110 lb. The dimensions are 33x20x24 and the speed 166 r.p.m. Each is driven by a 700-hp. synchronous motor.

Because of the great area covered by the various buildings of the General Steel Castings Company, and with future growth in mind, it was decided to concentrate the motor generators, transformers and feeder breakers in two substations. The largest of these (No. 1) is situated in the service building adjacent to the present foundry building. The other substation (No. 2) is nearly 1,000 ft. away in the roof trusses near the center of the machine shop. Arrangements permit controlling major equipment in substation No. 2 either remotely from No. 1 or locally.



Each boiler is fired by a single unit mill whose capacity ranges from 1,500 lb. to 8,000 lb. per hour

Along the wall of the large compressor room pictured on page 415 may be seen the main switchboard of substation No. 1. The transformers are located in rooms back of this board. Space in this substation is provided for three banks of 13,200/2,200-volt transformers, two banks of 2,200/220-110-volt lighting transformers, two banks of 2,200/440-volt power transformers, eight 13,000-volt truck switches, and a main switchboard adequate for the ultimate development.

In substation No. 2 space is provided for three banks of power and lighting transformers, twenty-two 2,200-volt truck switches and seventy-two power and lighting breakers.

Incoming power is metered twice, once by the Philadelphia Electric Company and once by the General Steel Castings Company. At present two banks of power transformers are installed for incoming power, one a spare.

This article was prepared with the co-operation of W. R. Chambers, chief engineer of the General Steel Castings Corporation, and Earl C. Metzer, power engineer.

Increased Voltages for Synchronous Machines

By C. M. Laffoon
Power Engineering Department
Westinghouse Electric & Manufacturing Company

TO KEEP down the cost of switching equipment, cables and reactors, it has bee nnecessary with the very large steam-turbine-driven generators to adopt a 22,000-volt design.

There has been an increased demand during the past year for larger capacity 1,800-r.p.m. turbine generator units. On the basis of using the best rotor materials available at the present time, it appears feasible to build 1,800-r.p.m. single-unit generators up to 200,000-kva., 80 per cent power-factor rating with air as the cooling medium. A further increase in rating can be obtained by designing generators with a short-circuit ratio appreciably less than unity. With hydrogen cooling, the upper limit in rating of the single-unit 1,800-r.p.m. generator can be raised to 250,000 kilovolt-amperes.

Preferential Voltage Range

For each generator rating there is a preferential voltage range, and machines with voltage either above or below this range can be built only at a sacrifice in cost, decrease in rating, and a reduction in the economy of performance. With large-capacity machines under consideration, the most desirable voltage from the generator standpoint is usually between 13,800 and 22,000 volts. There is a demand for large-capacity turbine generators having winding voltages up to 22,000 volts. This is because of the increased cost of circuit breakers, switches, cables, and reactors for carrying the large currents at the lower-voltage machines under normal and transient operating conditions. There has been no demand for a materially increased rating in waterwheel-driven generators, and the currents to be handled are not excessively high. Most hydro-electric stations are long distances away from distribution centers, consequently, relatively high transmission voltages and step-up transformers are required. For these reasons there is no general need for exceeding the present waterwheel generator voltage standards.

At the present time there are a number of turbine generators either in service or under construction by the different American manufacturing companies with 22,000-volt armature windings. In the design of high-

voltage turbine generators, serious consideration must be given to the insulation of the armature conductors. The type of mica insulation used on 13,800-volt windings is satisfactory as insulation for much higher terminal voltages. The most difficult problems are those involved in manufacturing, handling, and assembling the windings in the slots, and those due to operating conditions after the unit is in service.

To keep the voltage gradient satisfactory it is necessary to avoid sharp corners on the conductors and air pockets between layers of insulation, and to use a sufficient amount of insulation material. Special precautions and methods of handling, as well as careful inspection of the coils during the different stages of manufacture are required. After the unit is placed in operation, relative movement between the insulation and the copper causes difficult service conditions, due to temperature differences. This effect is greater in high-voltage than in lower-voltage machines. In the former insulation is thicker and there is a greater temperature difference between the outside of the insulation and the bare copper, than for the lower-voltage units.

With the higher-voltage windings, it is considered necessary to keep metallic structural parts remote from the end windings to decrease corona and reduce the voltage stress on the end windings. The coil ends are roped down to heavy micarta coil supports, as at *A* Fig. 2, that are located at short space intervals around the ends of this winding. The coil ends are clamped together between treated wood blocks held with fiber bolts, as at *B* Figs. 1 and 2. These figures show coil ends and the method of bracing used on large 22,000-volt, 1,800-r.p.m. turbine-generators.

Based on experience with several 18,000-volt synchronous condensers that have been in service on the Pacific Coast for approximately 10 years, and on fifteen years' service with the single-phase Norfolk & Western Railroad generators that are provided with 19,000-volt insulation and operate at 11,000 volts with one terminal grounded, it is felt that turbine generators wound for 22,000 volts should give satisfactory operation provided adequate judgment and precaution are followed in their operation. It would not be recommended that a high-voltage generator be connected directly to a transmission line or distribution system if the conditions were such that the unit would be subjected to dangerous potential surges.

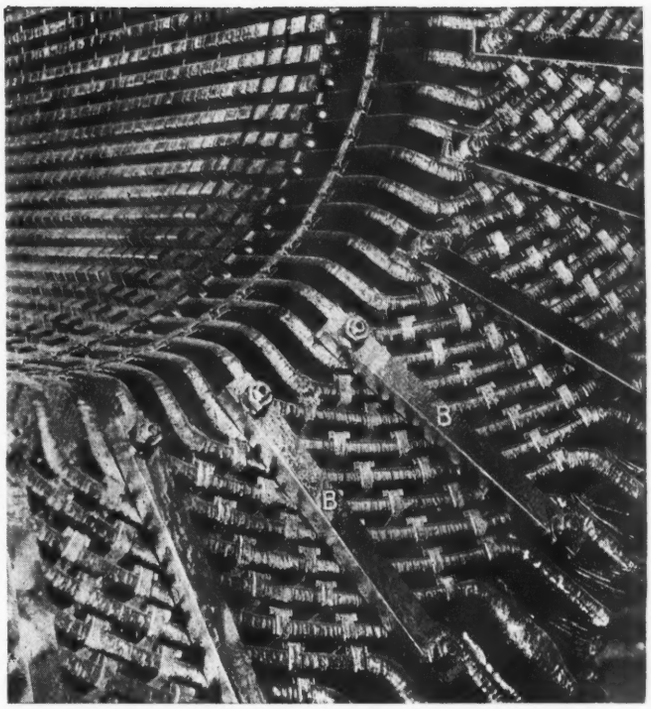


Fig. 1—The coil ends are clamped together between treated-wood blocks *B*

Generators provided with higher-voltage winding require larger physical dimensions and cost more to build than units wound for moderate voltages, on account of more space being required for the conductor insulation. Whether such units can be justified from the cost standpoint depends on the savings that can be made in circuit breakers, cables, and other auxiliary equipment.

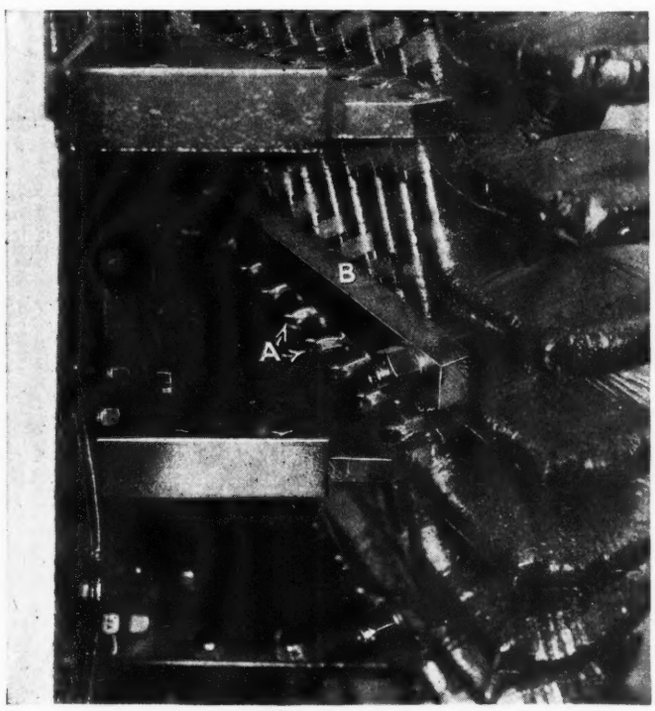


Fig. 2—The coil ends are roped down to heavy Micarta supports, as at *A*, that are located at short space intervals around the ends of the windings

Model of Rock Island development before the dam and power house was in place. This model is 64 ft. long x 32 ft. wide

ALDEN HYDRAULIC LABORATORY:

Workshop of Modern Research

Adequate hydraulic laboratory facilities in this country have been generally lacking. However, much valuable hydraulic research work has been done in the laboratories of the manufacturers, the power companies, and the universities. In this work the Alden Hydraulic Laboratory of the Worcester Polytechnic Institute has taken a pre-eminent part.

By F. A. ANNETT
Associate Editor of POWER

IN THE design of hydraulic structures there are many problems not amenable to a complete mathematical analysis. Even when a design can be satisfactorily calculated, there are features relative to locating the structure in the river that cannot be determined in that way. Such problems can only be accurately solved experimentally with models in a laboratory. Research of this kind has been so beneficial, not only in accurately predicting the performance of structures and in improving their operation, but also in reducing the ultimate cost of the project, that there is an ever-increasing amount of this work being done.

Waterwheel manufacturers have their own laboratories in which research is conducted on the parts of hydraulic structures they design. This, however, is only part of the problem of working out a satisfactory design for a water-power development. The best location of the structure relative to the direction of flow, the most efficient shape of discharge openings, the location of temporary discharge openings through dams, the best shape of the dam's apron to prevent erosion, economical height of cofferdams, the handling of ice, and many other problems must all be solved by studying models of whole projectors or their parts.

The importance of these problems and many others has caused a great deal of attention to be focused on a national hydraulic laboratory. Only recently has Congress passed the bill sanctioning the construction of such a laboratory. However, while effort was being made to obtain a national hydraulic laboratory a vast amount of research work was and is now being conducted in the hydraulic laboratories of the universities and industrial establishments.

The successful way in which some of the universities have been conducting this work is the best evidence that they should continue doing so. Some of the university laboratories are ideally located for conducting hydraulic research of practically every kind, and they should be encouraged to continue. This is not an argument against a national hydraulic laboratory, any more than the research laboratories of industrial establishments, commercial laboratories, or those of the universities are opposed to the United States Bureau of Standards. All of these laboratories have contributed work of inestimable value to the progress of this country and of the world. Each has its place in the search for new facts and the application of known principles. Similarly, there is opportunity for a national hydraulic laboratory, for the commercial

hydraulic laboratories and for those of the universities.

A committee on survey of hydraulic research of the A.S.M.E. in its 1929 report lists sixteen universities and colleges in this country that are doing hydraulic research work. The scope of some is quite limited, while in others extensive programs are carried out. One of the best examples of what a college hydraulic laboratory that has the proper facilities may do is found in the Alden Hydraulic Laboratory at Worcester Polytechnic Institute, Worcester, Mass. At this laboratory, which is in charge of Prof. Charles M. Allen, studies are being made on models of five of the largest water-power projects in this country, in addition to draft-tube investigations for a large company in Canada. Some of the models include th whole project. For example, the Rock Island project on the Columbia River is reproduced to scale on a model 64 ft. long x 32 ft. wide. These model experiments included tests on dams, spillways, intakes, diversion channels, tailraces, river beds, and other features. In addition, extensive experiments have been made on piezometers, pitot tubes, and Venturi meters both standard in the laboratory and Venturi meter sections in the field.

It was in this laboratory that Professor Allen developed his salt-velocity method of measuring the flow of water in closed conduits and in open channels. This method is used extensively for measuring the flow of water, and is accepted as one of the most reliable ways of determining the discharge rates of waterwheels. A slug of salt solution is injected into the water, and the time it takes this solution to pass two points in the flow line is noted electrically. From this record and the dimensions of the pipe line the volume of water may be accurately determined.

Another outstanding piece of research work done at the Alden laboratory was a series of tests on twelve draft-tubes models submitted by waterwheel manufacturers and a power company. A paper on these tests by Prof. C. M. Allen and I. A. Winter was presented before the American Society of Civil Engineers Jan. 17, 1924.

One of the features of the laboratory is its possibilities for almost unlimited expansion. It is about 5 miles from the city of Worcester on a power site that at one time

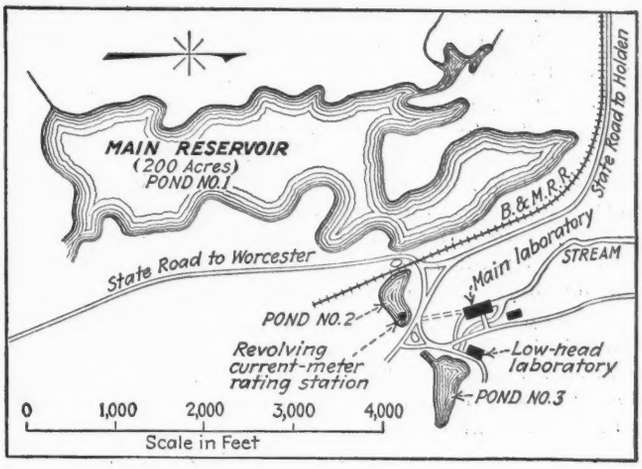
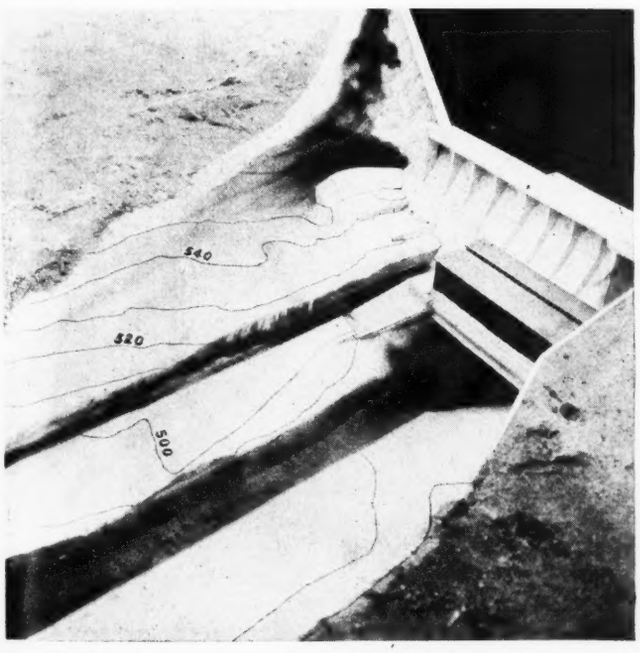


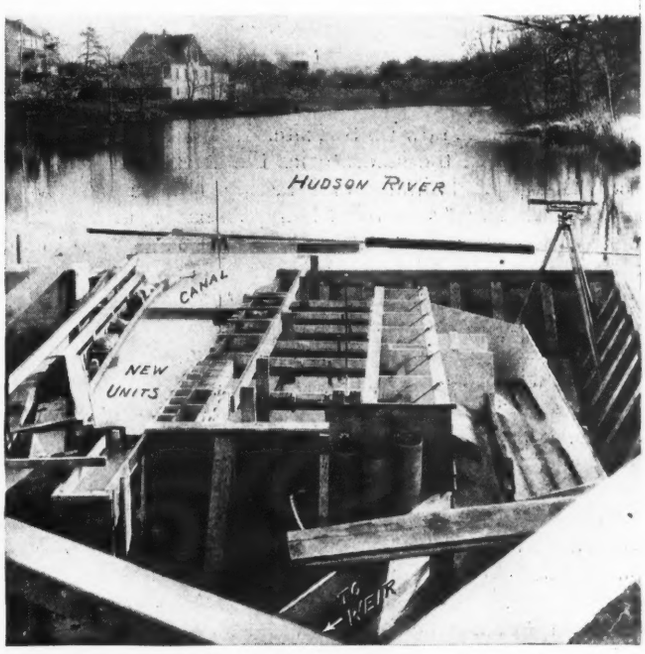
Diagram of the laboratory's property

was utilized for manufacturing purposes. At present the laboratory property includes a 600-acre tract of land, about one-third of which is covered by three storage reservoirs, as shown in the diagram. These reservoirs have sufficient storage to insure water for a much larger program than any the laboratory has undertaken. Last year its activities were unusually large and the season exceptionally dry, yet there was an ample supply of water for all purposes. The water is always clear, which is an important factor in laboratory work. Another feature that is desirable for a laboratory is proximity to materials used in making models. About everything of this kind can be obtained on short notice in Worcester, this city being noted for the diversity of its manufactured products. On the laboratory property there is available a wide variety of materials, from silt to the coarsest gravel for use in the models of river beds.

The main pond has an area of 200 acres and is used for reserve storage. It discharges through two headgates into pond No. 2, having an area of four acres. In the latter there is a current-meter rating station consisting of a boom 84 ft. long supported at the center and rotated about a vertical shaft imbedded in a large boulder



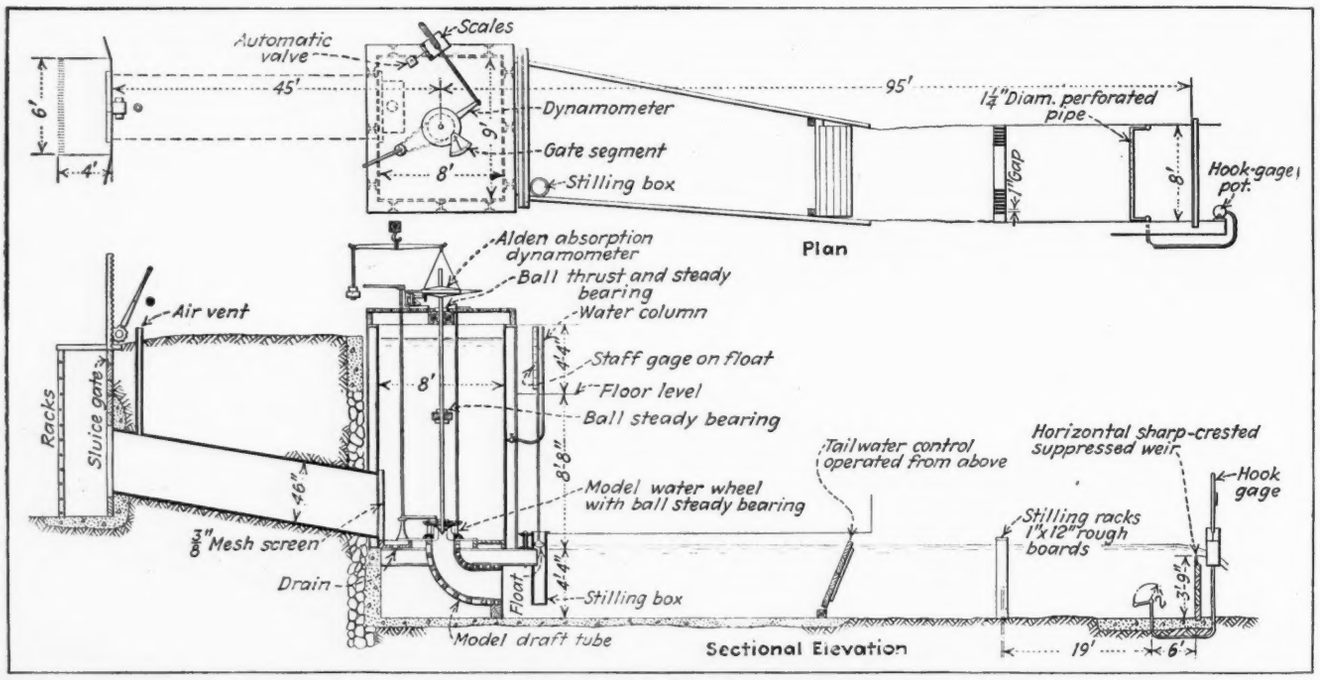
Model of the Fifteen Mile Falls development of the New England Power Company



Model of the Spier Fall development of the New York Power & Light Corporation

and conveniently located in deep water about 50 ft. from shore. The boom is carried on roller bearings and is driven by a waterwheel under a 6-ft. head, near the spillway of the pond. When a current meter is attached to the outer end of the boom it has to travel about 260 ft. in one revolution of the testing station. This distance insures that any disturbance set up in the water by the meter on one revolution will become quiet or depart radially before the meter passes the next time. Long series of tests have proved this rating station to be ideal for its purpose.

From pond No. 2 a 40-in. steel pipe about 400 ft. long leads to the main laboratory under a head of 30 ft. The overflow from pond No. 2 and the discharge from the wheel driving the current-meter rating station goes into No. 3 pond, which is two acres in area. A short 46-in. pipe leads from this pond into the low-head laboratory and provides a head of 15 ft. At the overflow from this pond there is a site for testing models of power projects. A model of the Spier Falls, N. Y., development on the Hudson River is now on this site. Below the overflow of pond No. 3 and the laboratories the stream has a grade that allows of building and testing models of power projects at almost any point along its banks, and of taking out the necessary water for their operation without interfering with any other experiments that may be going on below. Last year 25 to 30 men were working on models and tests at one time.



Plan and elevation of the low-head laboratory

The main laboratory is a wooden building 110 ft. long x 45 ft. wide, with a first floor and a basement, both of which are available for testing purposes. As previously mentioned, a 40-in. pipe about 400 ft. long connects the main laboratory with pond No. 2. This pipe provides means for a variety of experiments, such as the determination of friction losses due to flow, and measurement of flow by the salt-velocity method, by pitot tubes and by pitometers. It was on this pipe that Professor Allen made his first experiments with the salt-velocity method of water measurement.

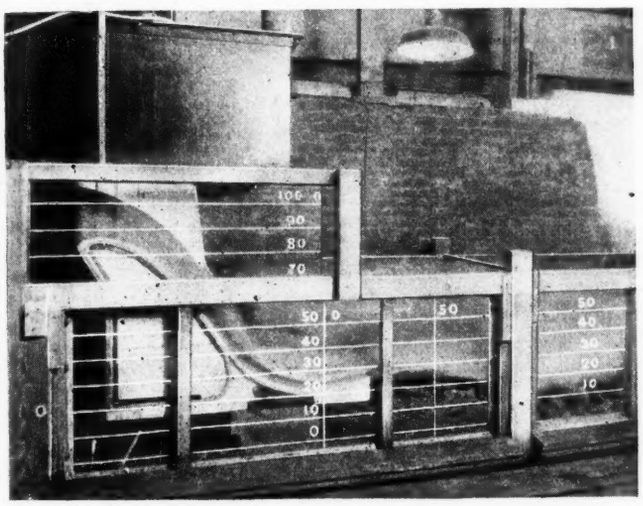
On the pipe line immediately inside the laboratory is a Johnson differential surge tank adapted to experimental purposes. Beyond the surge tank is a 36-in. Venturi tube, and then a Dow valve is installed. The pipe line terminates in the scroll case of a 100-hp. S. Morgan Smith vertical Frances turbine that is connected by belt to a 75-kw. generator. A branch from the pipe line connects to a 15-in. Platt wheel that is also connected to a generator. Each wheel may be tested by an Alden absorption dynamometer and a 10-ft. weir, the latter located at the far end of the weir flume in the basement. Current-meter tests are also made in this flume. There is also space in the basement for river- and dam-model testing. At present tests are being made on models of the dam for the Osage River development and the dam of the Safe Harbor project on the Susquehanna River. These are two of the largest water-power projects under construction in this country. A model of the circular spillway for the earth dam on the Deerfield River (Mass.) was also tested in this laboratory.

Near the intake end of the Venturi tube a 12-in. and a 6-in. line branch from the 40-in. pipe. The 12-in. line has a Venturi tube connected into it, and discharges into a wasteway over the standard weir or into a 50,000-lb. weighing tank. The latter allows of calibrating the Venturi meter and the weir by weighing the water. Salt-velocity and pitometer ratings can be made in this line, which also supplies water to model-dam experiments.

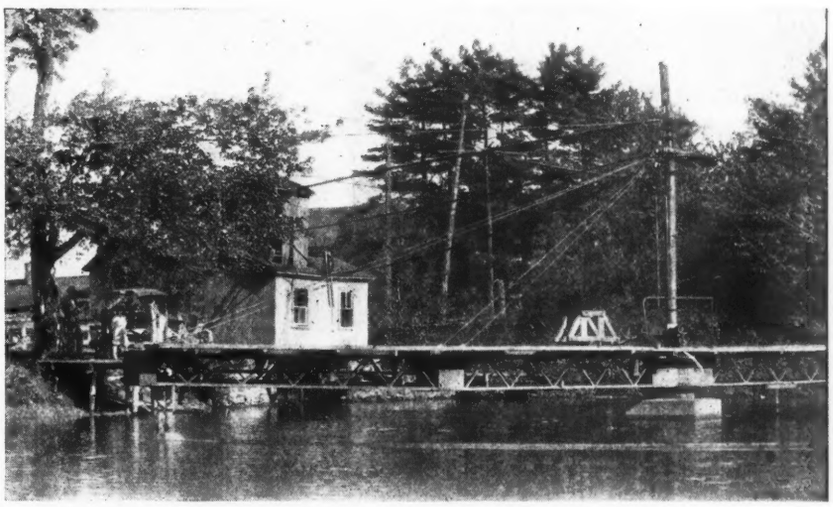
The 6-in. line runs to an experimental and a weighing tank and can be used for a variety of purposes. It supplies water to a 6x15x6-ft. tank built for testing models of penstock intakes for the Electric Bond & Share Company. The discharge from this tank is measured in the weighing tank or allowed to run to waste. Both the laboratory buildings are supplied by a 6-in. city water line at 135 lb. per square inch pressure. There are also several pumps of various kinds in the laboratory, and these can readily be tested for capacity and efficiency, using the weighing tank for accurately determining their discharges. Meters of various types and sizes can be rated by the same means, and a large number of Venturi meters have thus been calibrated for exceptionally accurate work.

A concrete dam and a weir in the wasteway in front of the main laboratory control and measure the flow, and a concrete flume along the side carries water to a distributing forebay. An overshot wheel is supplied from this forebay, as is also a model of the Fifteen Mile Falls development of the New England Power Company. The overshot wheel can be tested for efficiency and capacity by a prony brake in the main laboratory and a weir at the end of the concrete flume.

In the low-head laboratory, which is housed in a one-story-and-basement building 70 ft. long and 36 ft. wide, there is a steel-plate flume in which models of water-wheel runners can be tested under a 14-ft. head. Model draft tubes are also tested in this flume. It was in this laboratory that the long series of tests on draft tubes previously referred to was made.



Above—Tests on the dam for the Conowingo development, using large broken stone to stimulate the river's bed



Right — Circular current-meter rating station has a boom 84 ft. long supported at the center and rotated about a vertical shaft imbedded in a large boulder located in deep water

After leaving the laboratories the water goes back into the river and is available for testing models of entire power projects. The grade of the river below the laboratories makes it ideal for this purpose. One of the chief assets of the laboratory is the complete control of the watercourse from the storage reservoirs down to the metropolitan district of Worcester.

A brief description of some projects of which models have been tested will best show the extent of the work carried on inside and outside the laboratory. As already mentioned, a model of the entire Rock Island development has been constructed on the river's bank just below the laboratory by the Stone & Webster Engineering Corporation. This model, 64 ft. long and 32 ft. wide, reproduces the entire section of the river where the power development is being made, on a scale of 1 to 100. The project is on the Columbia River in Washington, about thirteen miles below Wenatchee. The power house will initially contain four 15,000-kw. generating units, with provision for six additional units. A complete set of models of dams, spillways, power house sections, and fish ladders was made and tested in the model of the river section.

A model of the dam, the power house, the spillway, and the river below the Fifteen Mile Falls development of the New England Power Company was built in 1928. This project is on the Connecticut River near Lebanon, N. H., and will have a capacity of 200,000 hp. Studies are being made on a model of the Spier Falls development of the New York Power & Light Corporation on the Hudson River. This project was originally laid out for ten 5,000-hp. units to operate under an 80-ft. head. Five of the original units were installed and later a 9,000-hp. unit was added. Now two 57,000-hp. units are being installed.

Model tests have been made on the spillway apron of the dam for the Conowingo development on the Susquehanna River. This project will have an ultimate capacity of over 600,000 hp. A spillway model of the 220,000-hp. Osage development was tested to determine the best form of apron below the dam and the discharge coefficient through the gates. A model of the dam of the Safe Harbor development on the Susquehanna River is being tested. This project will have a capacity of over 500,000 hp. when completed. The foregoing gives an idea of the extent of the work carried on at the laboratory. These projects do not include all that have been tested or are now under test at the laboratory.

A story of Alden Hydraulic Laboratory and its work would not be complete without a statement regarding the men who have been responsible for its inception and development. Professor George I. Alden discovered the site and recognized its great possibilities as a hydraulic project. Professor Alden, for whom the laboratory was named, was a professor and later a trustee of the institute for many years. He never failed to manifest his confidence in the practicability of the undertaking, and has repeatedly contributed to its betterment.

Prof. Charles M. Allen, a graduate of the institute in 1894, has lived and worked with this plant since its origin. To him credit is due, in a large part, for the novel

and important developments that have taken place there. One of the characteristics of Professor Allen's genius is to take something that someone is ready to assign to the junk heap and turn it into a useful piece of equipment. This constructive characteristic has not only secured for the laboratory much valuable equipment at little or no cost, but has brought to it many famous, but no less useful, pieces of apparatus.

Through the efforts of C. H. Morgan, a former trustee, the Venturi tube in the 40-in. pipe line was obtained. This had been used at the Chicago World's Fair, where all the water used at the fair grounds passed through it. The Fairbanks testing machine scales that support the 50,000-lb. weighing tank was on exhibition at the Centennial Exhibition at Philadelphia in 1876. It was known as the "Half-Dollar Scales," because the beam would register when a fifty-cent piece was placed upon the platform. Because of its size and accuracy it is a highly valuable piece of equipment. These scales were recently tested up to full load by a sealer of weights and measures of Massachusetts, and found to be correct and sensitive after 56 years of service.

The 24-in. Pelton waterwheel in the main laboratory is one that was sent to Holyoke for testing purposes at the time of the first Niagara installation. The overshot wheel was made from the two flywheels that were on the Alden triple-expansion engine, and the pulley used for the prony brake on it was formerly the main drive in the Washburn shops. Thus Professor Allen by the aid of his many friends has built a hydraulic laboratory that is outstanding for its many accomplishments.

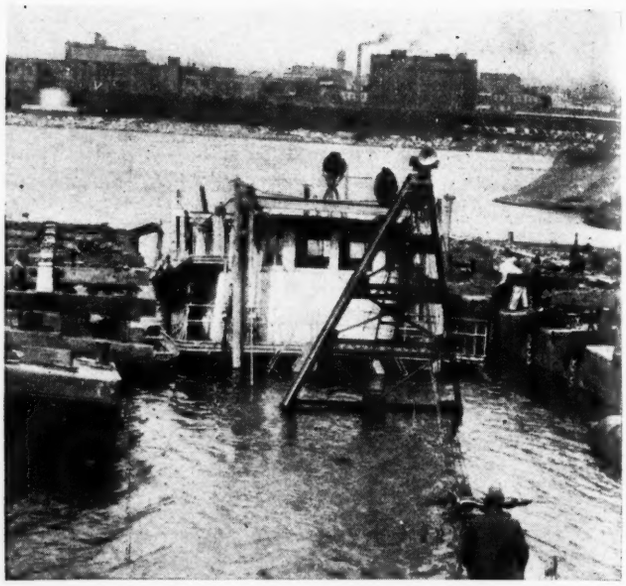
Dry Ice Shipped From Tropics Protected by 12-In. Corkboard

BRINGING the first shipment of condensed cold from the tropics to New York City the steamship Panuco of the New York & Cuba Mail Steamship Company sailed on Aug. 5 from Tampico. She carries, in a section of her hold insulated with twelve inches of corkboard, some 400,000 pounds of "sub-zero ice," or solid carbon dioxide, a product of wells 18 miles inland from Tampico in the Quebracho district of Mexico's famous oil fields. This paradox of bringing "ice" from the tropics to the North is without precedent.

Drilling for oil, the Globe Petroleum Company struck a supply of carbon-dioxide gas, apparently inexhaustible, which flows to the surface at a pressure of 1,000 lb. per square inch. For years the Globe wells have been shooting into the air sufficient gas to make 1,600 tons daily of solid carbon dioxide. Now, with a rapidly increasing demand for this product in the United States, plans have been made to convert the gas into solid form and ship it to market.

The Compania Industrial de Carbono, S. A., a subsidiary of the Carbonic Products Company, New York City, has erected an initial plant of 40,000 lb. daily capacity for manufacturing the product at the source of supply. There is enough gas, according to company officials, to manufacture 4,000,000 lb. a day.

Three ships of the New York & Cuba Mail Line have been equipped with chambers to hold 200 tons each. Floors, ceilings, and walls of these compartments are insulated against heat by one foot of corkboard.—*Refrigeration.*



Getting ready to raise the dredge on which the electrical equipment was submerged

Electric Machines Under Water for Six Weeks

MODERN designs of electrical equipment have insulation that will stand water, without serious injury, to a surprising degree. As an example of this, a dredge sank in the Illinois River at Peoria, Ill. It was equipped with about 770 hp. of electric motors, and a 75-kw. generator, together with necessary control, switchboard, and transformers. The dredge sprang a leak and sank. After being six weeks under water, arrangements were made to raise it and to remove the electric equipment for reconditioning. This was done, and the electric machinery was sent to the Chicago service shop of the General Electric Company, with the exception of a 600-hp. motor, which with the cables in conduits were cleaned and dried out at the dredge.

At the service shop the motors, control and transformers were cleaned, placed in an electric oven, and baked for 72 hr. at a temperature of 250 deg. F. Meter readings were then taken, at which time the insulation resistance checked satisfactorily. Then a test to ground was made according to A.I.E.E. standards. All the equipment was repaired without rewinding, but new wedges had to be installed in the rotors and stators. All the windings were then dipped twice in baking varnish, and, after dipping, baked for 12 hours.

✦

AVERAGE PRODUCTION of electricity by public-utility power plants in the United States in July was 253,900,000 kw.-hr. per day, about 2 per cent less than the daily production in June. This rate of change in output from June to July is the normal decrease. The output for July of this year was about 2½ per cent less than for July, 1929. With the exception of the Pacific States, which showed a 7 per cent increase, the June-July per cent decrease in water-power production was as follows: New England States, 22; Middle Atlantic States, 16; East North Central States, 26; West North Central States, 16; South Atlantic States, 26; East South Central States, 2; Mountain States, 1.

Installation of

UNIT HEATERS

Reduces Steam Consumption

By H. W. BENTON
Plant Engineer, Pratt & Whitney Company
Hartford, Conn.

THOSE interested in the heating of buildings are, at the same time, interested in what it costs, and how to maintain satisfactory temperature during the heating season, particularly in manufacturing space.

Steam heating systems, generally speaking, have been supplied with steam at all pressures, according to prevailing conditions, these pressures varying from a vacuum all the way to possibly even 100 lb. per square inch. In some cases the heating system is supplied with hot water, circulation being accomplished by motor- or steam-driven pumps.

My own experience has brought me in contact with many different types of heating systems, and, like others in somewhat similar circumstances, I have wondered many times just what the actual cost of heating service amounted to and whether changes made were actually profitable. But the reduction in steam consumption resulting from the replacement of the old heating systems at the Pratt Whitney's plant, Hartford, Conn., by unit heaters has been clearly evident.

The plant consists of 21 brick buildings; some three-story with basement and some four-story with basement. These buildings are of the usual type, built of brick, with windows along all four sides. The roofs are flat. Interior construction is of wooden posts, wooden beams, and wooden floors. Basement floors are concrete. The buildings are in good condition.

Some of the buildings were heated with blast coils, and the hot-air ducts were built into the brick walls with hot-air outlets provided for each floor. The cold air return from these floors was originally intended to find its way down the stairway shaft to the basement, thence through the steam-heated blast coils to be heated and returned to the building. Some of the buildings were heated with hot-water, forced-circulation direct radiation, while other buildings were heated with low-pressure steam supplied to direct radiation made up of wall coils supported on hook plates along the walls just beneath the windows.

Unit heaters were placed in this plant progressively commencing with installation in only one building. It was necessary to prove to the management whether unit heaters decreased heating costs, and to prove this point I included in the equipment a weighing-type condensation meter for installation on the drain line from the heating system in this building.

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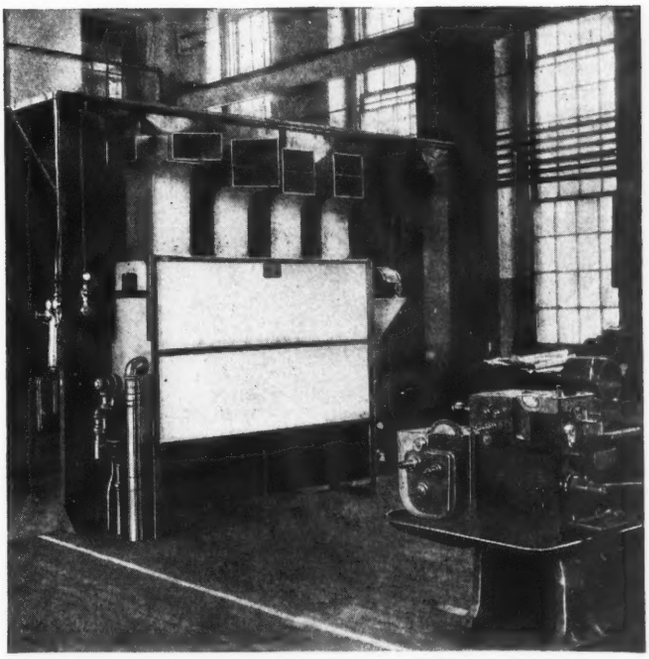


At the right of the floor-type unit heater can be seen some of the original wall coils, now out of service

Eleven unit heaters were installed, each having a radiating capacity of 149,000 B.t.u. per hour, with steam at 2 lb. pressure and the entering air at 60 deg. F. The flow of condensation from the unit heaters was controlled by radiator traps installed directly at the outlet from each unit, and all condensation drips were connected into a common return line piped to the condensation meter. Thus all steam delivered to the heating system of that building when condensed into water had to pass through the condensation meter on its way back to the steam plant, and we were able to obtain a daily record of the steam used for heating that building.

The unit heaters in the building were equipped with thermostatic control adjusted so that the temperature was maintained constant at 70 deg. F. Consumption of steam thus varied with changes in outside temperature.

While this installation was being made, there were numerous comments as to how foolish it was to expect so small a unit to heat the building, so when the work was completed and the system put in operation, I said nothing, but merely watched what happened. About six weeks of operation had passed when the management asked what it would cost to extend that same heating system to other buildings. The figures were prepared

and presented, with the result that approval was given to extend the system.

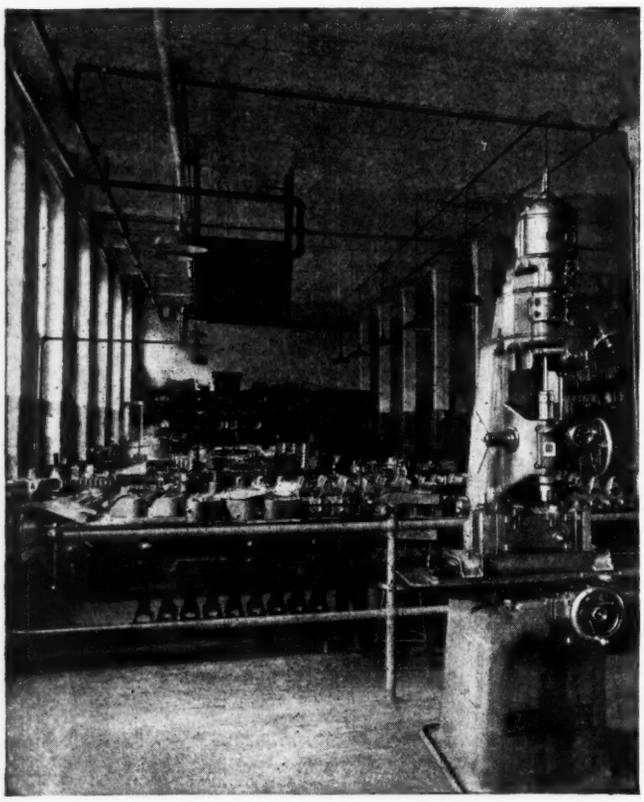
The table gives the figures developed from the meter readings on these several heating systems.

Columns 1, 2, and 3 show the daily steam consumption in pounds of steam per day of twenty-four hours for three groups of buildings heated entirely with suspended unit heaters.

All of the unit heaters are controlled with full automatic thermostatic control, and they are supplied with steam at 1½ to 2 lb. pressure. All condensation returns by gravity, and in each case through a weighing condensation meter.

Column 4 of the table shows the pounds of steam per day of twenty-four hours used in a direct-radiation, wall-coil heating system, where the wall coils are supported on hook plates beneath the windows and along all the outside walls of the building.

This particular heating system is a thoroughly first-class job. All radiators are properly fitted with thermostatic traps in good condition. The system is supplied with steam at 1½ to 2 lb. pressure and all condensation



A suspended-type unit heater installed in a section of the tool room

returns are by gravity and are also piped into a weighing-type condensation meter.

The building, however, is of reinforced concrete construction throughout, with steel sash and wire insertion glass windows. The floors and roof are of concrete, the roof being finished with water proofing. This building, because of its tighter construction, is easier to heat than those in which unit heaters were installed.

We have, therefore, four different groups of buildings, three of them heated by unit heaters and one by direct radiation, all being operated with steam supplied at the same pressure. All condensation returns by gravity and all buildings are maintained at 70 deg. F., so that the operating conditions are exactly alike. The buildings in Column 1 have a total floor area of 152,165 sq.ft. The buildings in Column 3 have a total floor area of 125,886 sq.ft. and the buildings in Column 4 have a total floor area of 63,057 sq.ft.

Data in the table show that the unit heaters during the 31 days of January, 1929, operated with 28.3 per cent

POUNDS OF STEAM USED FOR HEATING JANUARY, 1929

		Unit Heaters 1	Unit Heaters 2	Unit Heaters 3	Direct Radiation 4	Outside Average Daily Temp. Deg.
Jan.	1					28
	2	199,000	223,000	216,000	131,000	32
	3					26
	4					24
	5	100,000	101,000	94,000	66,000	20
	6					47
	7	61,000	69,000	67,000	30,000	
	8	61,000	62,000	56,000	37,000	20
	9	39,000	63,000	42,000	32,000	28
	10	36,000	42,000	48,000	33,000	40
	11	39,000	55,000	30,000	34,000	30
	12	141,000	124,000	98,000	74,000	30
	13					26
	14	57,000	50,000	70,000	33,000	11
	15	62,000	73,000	68,000	43,000	18
	16	53,000	50,000	53,000	34,000	17
	17	49,000	49,000	42,000	37,000	22
	18	26,000	39,000	24,000	32,000	40
	19	77,000	66,000	86,000	48,000	43
	20					36
	21	49,000	59,000	59,000	39,000	28
	22	37,000	56,000	48,000	35,000	25
	23	38,000	47,000	54,000	35,000	34
	24	43,000	57,000	52,000	32,000	28
	25	44,000	44,000	41,000	29,000	24
	26	114,000	116,000	99,000	59,000	26
	27					24
	28	67,000	68,000	66,000	41,000	22
	29	67,000	60,000	108,000	38,000	14
	30	49,000	47,000	93,000	34,000	20
	31	50,000	49,000	63,000	33,000	22
		1,558,000	1,669,000	1,677,000	1,039,000	26.5

Column 1: $\frac{1,558,000}{152,165}$ = 10.2 lb. per sq. ft. of floor area

Column 4: $\frac{1,039,000}{63,057}$ = 16.4 lb. per sq. ft. of floor area

Column 3: $\frac{1,677,000}{125,886}$ = 13.3 lb. per sq. ft. of floor area

less steam than would have been required for heating had the building been equipped with direct radiation similar to that installed in the buildings represented in Column 4 of the table.

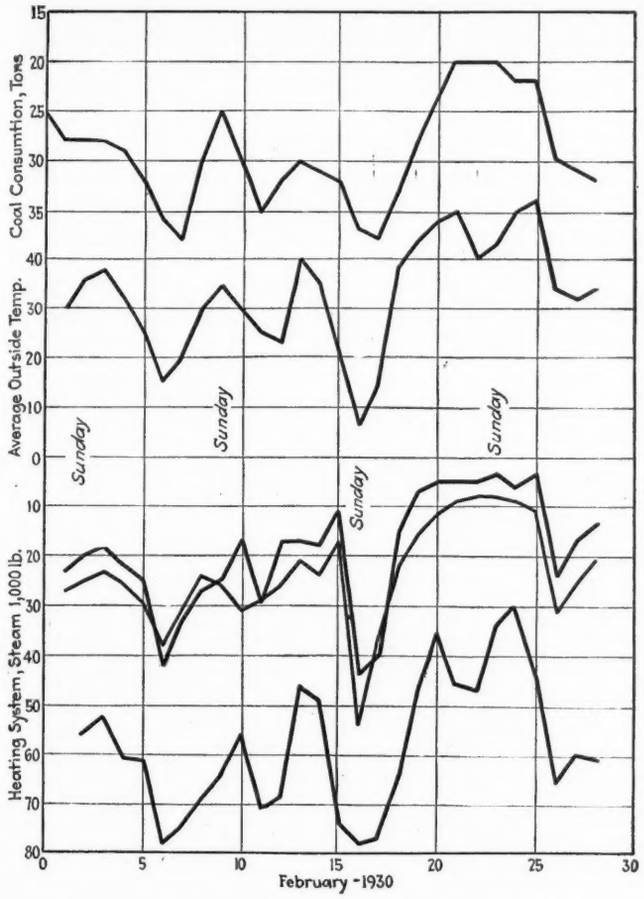
Similar data for December, 1928, showed the unit heaters to consume 39.4 per cent less steam.

The reason for this difference in saving between December and January is because of lower temperatures during January. The unit heaters were thus in operation a greater percentage of the time than was the case in December. Therefore, there was less loss in the heating system represented by the figures in Column 4, and it is quite plain that thermostatically controlled heating systems are more efficient in the saving of steam in mild weather than in cold weather. These data show the effectiveness of thermostatic control and, at the same time, the efficiency of unit heaters thermostatically controlled as compared with direct radiation.

By reference to the table and having in mind that these buildings have a ceiling height of fourteen feet, it is to be noticed that the unit-heated buildings, in Column 1, consumed in average of 0.33 lb. steam per day of twenty-four hours for each 14 cu.ft. of space. The group of buildings represented by the figures in Column 3 consumed 0.43 lb. steam per day of twenty-four hours for each 14 cu.ft. of space.

This difference can be accounted for by the fact that the group of buildings in this latter case were working overtime until 8:30 each evening, while the group of buildings previously mentioned had no overtime work.

The direct radiation, as represented by the figures in



Curves showing variation of coal and steam consumption with average outside temperature

Column 4, used 0.53 lb. of steam per day of twenty-four hours for each 14 cu.ft. of space, and the manufacturing processes were discontinued at 5 p.m.

The steam consumptions indicated for Saturdays and Sundays are greater than for any other two week days having nearly the same outside temperatures. The additional steam supplied takes the place of heat normally furnished by machines in operation and men at work. It shows clearly the importance of this source of heat when operating a heating system not under thermostatic control.

During the winter of 1929 and 1930 the number of buildings equipped with unit heaters was increased to sixteen, the condensation from which is measured by ten meters.

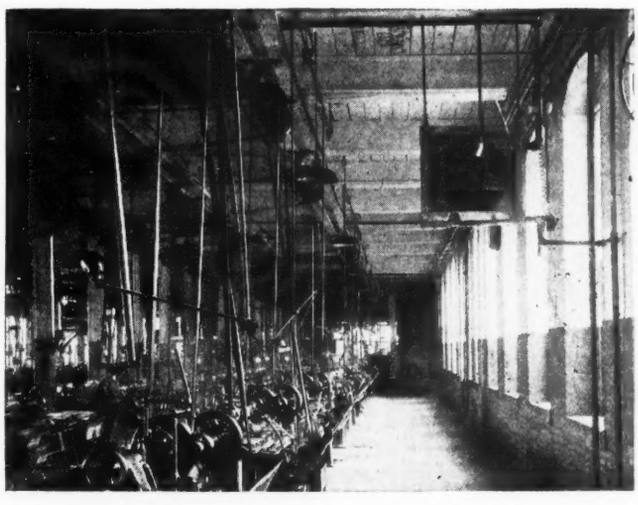
A graphic record of the steam consumed in each of these buildings is kept, together with the mean daily temperature reported by the United States Weather Bureau, and the coal consumption. Steam consumption curves for three of these buildings for February, 1930, together with the daily temperature and coal consumption curves, are given in the chart.

The scales for the steam and coal consumption curves have been inverted so that the curves will parallel the temperature curve. This they do fairly well, indicating that the thermostatic control varied the steam consumption with the outside temperature. In connection with the curve of coal consumption it should be borne in mind that the heating system is the exclusive load on the boiler plant and that there is no correction to be made for other steam requirements.

Unit heaters, to my mind, have many advantages. They can be suspended at the most suitable point in a building so as not to interfere with a desired machine layout. They can be moved, if necessary, to suit the machinery layout at a very little cost. They bring about a definite movement of air in a building, which results in more uniformity of building temperature. They are less expensive to install than direct radiation. During the summer months the fans can be operated, bringing about an air movement which is really quite a help to employees.

Direct radiation, when placed along the wall beneath the windows (which is a common location for such radiation), is usually covered with benches. Frequently the space under the benches is used to store boxes, bins, unused equipment, jigs, fixtures, and, in fact, a miscellaneous assortment of most anything. All this material in front of the radiator and the bench above the radiator retards the circulation of air over the radiator surface and thus prevents its effective performance. This, in turn, increases the heating system cost, because the radiator does not deliver the heat to the room as effectively as it would if these restrictions did not exist.

Wall coils are built into, and, one might say, fitted to the individual location in which they are installed, and do not, therefore, lend themselves readily to rearrangement. If rearrangement does become necessary, it is expensive. A great deal of the radiated heat from wall coils is absorbed directly in the building wall itself and a large part of it is lost. Such is not the case with the unit heater system.



Rear view of suspended unit heater in small tool department

Influence of ORIFICE DIAMETER on Diesel Fuel Consumption

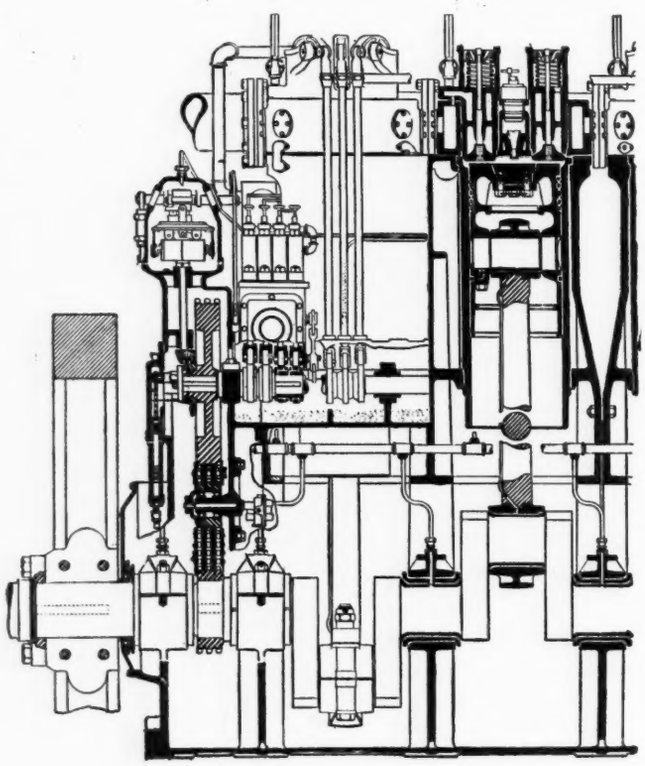
This article covers a series of tests concluded by the authors, naval officer post-graduate students, at Pennsylvania State College. The tests reveal a marked influence of the orifice area on the fuel consumption of a precombustion Diesel

By W. F. BUCH and C. J. CATER
Lieutenants, United States Navy

THE engine used in the tests was a single-acting four-stroke-cycle mechanical-injection Benz-type unit, with two cylinders of 9.9375-in. diameter x 13,9375-in. stroke. When operating at 325 r.p.m. its normal rating was 70 hp. The clearance volume of each cylinder was 85 cu.in., and the connecting rod ratio was 4.5 to 1.

The precombustion chamber occupies the central portion of the head, as will be seen from the cross-section of a similar Benz engine in Fig. 1. The outlet for this chamber to the cylinder is a perforated nozzle which is screwed into the lower part of the precombustion chamber and projects a very short distance into the cylinder. This nozzle, Fig. 2, originally had twelve equally spaced radial holes, each with a diameter of 0.098 in. and drilled at an inclination of 45 degrees.

Fuel is supplied to each cylinder by a jerk pump. Each plunger is a lap fit in a cylindrical bushing, or barrel, which forms one cylinder of the pump. The operating plungers of this arrangement are held to the cam by springs. The pump plungers themselves are returned to the bottom of their stroke by springs included in the pump proper. The suction valve is in the lower front of the pump. It is a plunger type and is held in the closed position by a spring and the pressure of oil in the pump during discharge. The suction pressure



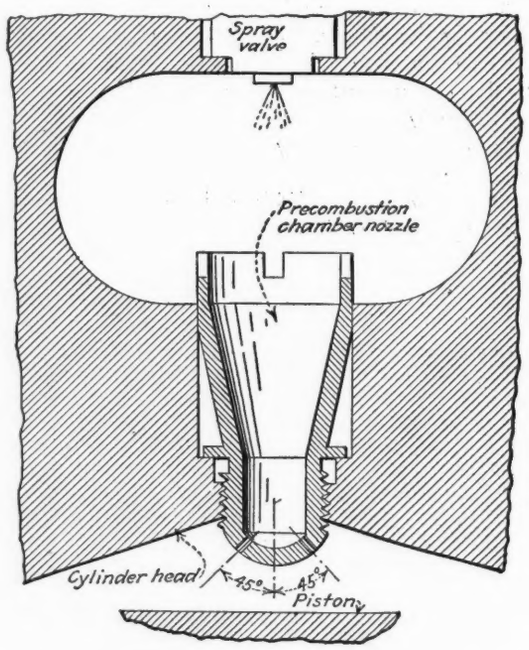


Fig. 2 (Above)—The precombustion chamber and nozzle

Fig. 1 (Left)—Section through a Benz engine similar to that used in the tests

in the pump during the suction stroke is sufficient to lift this valve and admit oil to the pump cylinder. The amount of oil pumped to any one cylinder is regulated by a cone point's spindle, or bypass valve, with a threaded shank, one of which is included for each cylinder of the main fuel pump. The governor actuates these spindles through a system of levers and cranks; if the engine overspeeds, the governor causes the spindles to back further off their seats. This allows part of the oil discharged by the pump plunger to pass back into the suction chamber, and the engine slows down.

The precombustion chamber exit nozzle supplied with

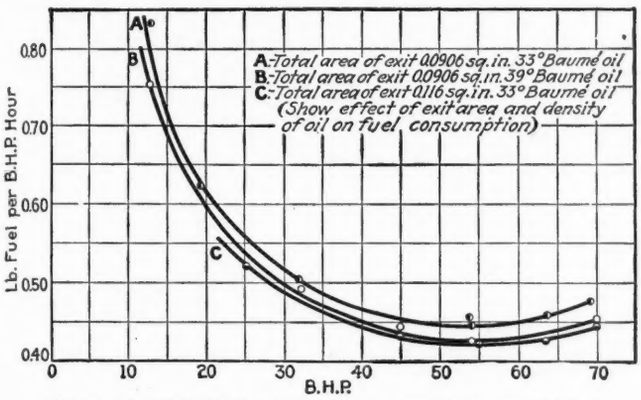

A-Total area of exit 0.0906 sq.in. 33° Baumé oil
B-Total area of exit 0.0906 sq.in. 39° Baumé oil
C-Total area of exit 0.116 sq.in. 33° Baumé oil
(Show effect of exit area and density of oil on fuel consumption)
Lb. Fuel per B.H.P. Hour
B.H.P.

Fig. 3—Specific fuel consumption with different nozzle areas and fuels

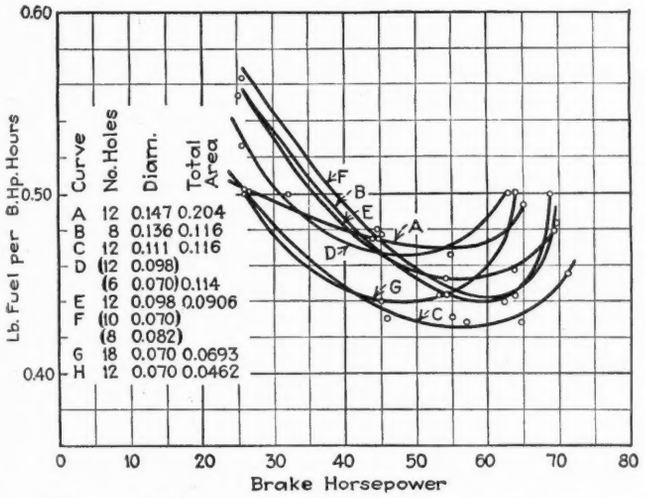


Fig. 4—Variation in fuel consumption with orifice areas

this engine has an area of .0906 sq.in. and is shown in Figs. 1 and 2.

Although the engine designers specified a fuel of 40 deg. Baumé gravity, it was decided to investigate the advisability of using less expensive oil of lower Baumé gravity, and at the same time to investigate the effect of changing the precombustion chamber exit nozzle design on the efficiency.

Upon completion of the several runs with 39.5 deg. Baumé oil, runs were made with 33-deg. oil, with the size and number of holes in the exit nozzle varied as follows:

Run	No. Holes	Diameter, In.	Angle, Deg.	Total Area
A	12	0.147	45	0.204
B	8	0.136	45	0.116
C	12	0.111	45	0.116
D	12	0.098	45	0.114
	6	0.070	30	
E	12	0.098	45	0.0906
F	10	0.070	45	0.0808
	8	0.082	30	
G	18	0.070	45 and 30	0.0693
H	12	0.070	45	0.0462
I	12	0.136	45	0.173

The valves were ground and clearances checked after each 25 hr. of operation. The exhaust and inlet valves were run with a clearance of 0.030 in., and the fuel pump with a clearance of 0.011 inch.

The work was discontinued after the completion of the H series in order that the data might be worked up. The completion of the data obtained indicated that series I should be run. In the meantime approximately three weeks had elapsed, during which the engine was used by the undergraduate students.

The engine was usually run 15 or 20 min. before a series of tests was begun. During that time load was gradually built up to the full rating of 70 hp. As soon as the water temperature had become steady at 95 to 100 deg. F. the run at 70 hp. was begun. The duration of a run was 40 min. Upon its completion the load was decreased to that of the next test to be run. As soon as conditions became steady that run was begun, and this procedure was continued until the series had been completed. The following data were taken and recorded every five minutes of a run: Time, fuel weight in pounds, r.p.m, brake load, temperature of circulating water entering cylinders, temperature of circulating water leaving the cylinders, weight of circulating water passed through engine, and exhaust temperatures. The

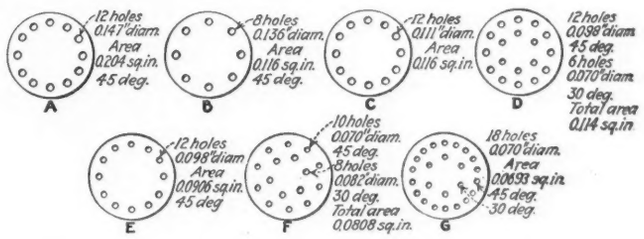

A
12 holes 0.147" diam. Area 0.204 sq.in. 45 deg.
B
8 holes 0.136" diam. Area 0.116 sq.in. 45 deg.
C
12 holes 0.111" diam. Area 0.116 sq.in.
D
12 holes 0.098" diam. 45 deg. 6 holes 0.070" diam. 30 deg. Total area 0.114 sq.in.
E
12 holes 0.098" diam Area 0.0906 sq.in. 45 deg
F
10 holes 0.070" diam. 45 deg. 8 holes 0.082" diam. 30 deg. Total area 0.0808 sq.in.
G
18 holes 0.070" diam. Area 0.0693 sq.in. 45 deg. 30 deg.

Fig. 5—Drillings of the several nozzles used in the tests

barometric pressure and room temperature were entered on each run sheet.

The results of the tests conducted for the thesis are recorded in Figs. 3 to 6, inclusive. In Fig. 3 are plotted three curves of fuel consumption per horsepower-hour against brake horsepower. Curve *B* was constructed from results obtained when a 39-deg. Baumé oil was run with the original precombustion chamber nozzle having twelve 0.098-in. diameter holes with a total area of 0.0906 sq.in. Curve *A* was constructed from results obtained by running the engine with the same nozzles as *B* and a 33-deg. Baumé oil. Curve *C* was constructed from results obtained with a different nozzle, having twelve 0.0111-in. diameter holes with a total area of 0.116 sq.in. Curves *B* and *C* practically coincide over the range for which *C* was plotted. This, we believe, brings out the fact that there is a relation between the area of the precombustion chamber exit nozzle and the gravity of the oil used.

The most efficient nozzle area for the 33-deg. Baumé oil was found by making several series of runs with different exit nozzle areas. The results of these runs are plotted in Fig. 4, while the nozzle opening used during the tests covered by the curves in Figs. 3 and 4 are shown in 5. The curves in Fig. 6 were plotted by the use of data taken from curves *A*, *C*, and *E* in Fig. 4, and are plotted for fuel per brake horsepower-hour against exit nozzle area. They indicate that the area of 0.116 sq.in. is very close to that which gives the best efficiency for the 33-deg. Baumé gravity oil.

We are of the opinion that the curves indicate that there is an optimum nozzle exit area for best economy

with a particular oil. We also believe the design of nozzle exit areas of this engine could be based on 0.15 per cent of the area of the cylinder. Then several runs could be made similar to those mentioned above for determining the exact area required for best operating characteristics and lowest fuel consumption.

The engine gave its full load rating with the arrangement of holes shown for *D* and *F*. However, the fuel consumption in all three cases are greater than with the twelve 0.098-in. diameter holes. From these curves we arrived at the conclusion that additional holes in the center of the precombustion chamber nozzle would be of no avail. It seems plausible to attribute the increase in fuel consumption under these conditions over that of the twelve holes mentioned, to the fact that the gases

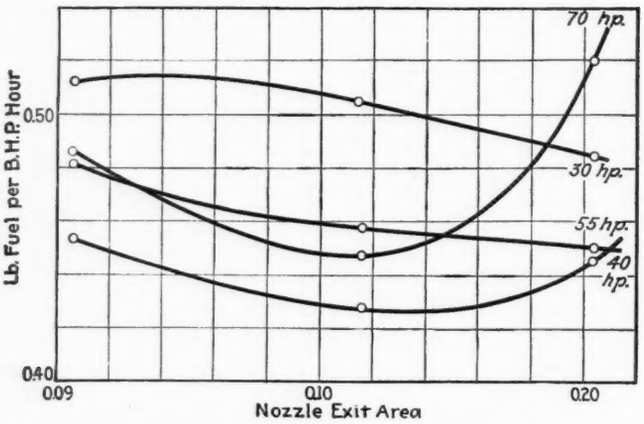


Fig. 6—Plotting on logarithmic scale shows optimum orifice area

issuing from the inner holes were striking the piston, reducing the turbulence as well as being partly cooled.

Since twelve 0.111-in. diameter holes is about the largest number that may be drilled in the present nozzle without reducing its strength below a safe limit, fewer holes were tried. Two curves, *B* and *C*, show the effect of decreasing the number of holes at the same time keeping the exit area the same. From these it may be seen that the larger number of holes gives the lowest fuel consumption. In other words, the largest number of holes was giving better combustion characteristics due to the better distribution and turbulence of these gases issuing from the precombustion chamber.

The following conclusions have been arrived at:

There is an optimum area of precombustion chamber exit nozzle for each density of oil used.

For design purposes, the exit nozzle may be assumed to have an area of 0.15 per cent of the area of the piston, for engines with dimensions proportional to the one reported.

The optimum nozzle area must be determnied for the kind of oil used and the particular engine.

The number of holes for an engine of this type, namely, with the precombustion chamber exit nozzle in the center of the cylinder, should be the maximum that will give the necessary area consistent with strength requirements of the metal used for the nozzle.

The angle at which the nozzle holes are to be drilled must be determined from test, 45 being a good place from which to start.

Diesel engines of today differ in so many respects, the main points of difference being speed, stroke, bore, and compression ratio, that it is practically impossible to evaluate accurately the ratio of the precombustion chamber exit area to the piston area. It might be possible to better the 0.15 per cent mentioned by obtaining data from various engine manufacturers and designers, and from that data to arrive at a safe value for this ratio. However, we are of the opinion that 0.15 per cent is a sufficiently accurate point on which to base design.

What to Expect in Future Boiler Efficiencies

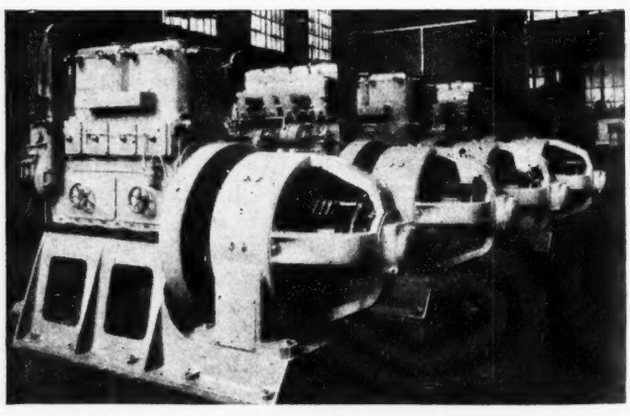
DURING the past 50 years boiler efficiencies under test conditions have been maintained consistently at about 80 per cent, as evidenced by the tests of Hoadley and Jacobus and such European authorities as Unwin and Donkin. The superheater, economizer, and air heater, heat-saving additions, have brought the test efficiency up to about 92 per cent when the power used by the boiler-room auxiliaries is not taken into account. It does not appear that these figures are likely to be notably exceeded, although propositions have been made to wash the remaining heat out of the flue gases, with a possible saving of another 2 per cent. If the gas losses are figured as 3 per cent, moisture in gas and air at 2½ per cent, carbon and carbon monoxide losses as 1 per cent, a total of 6½ per cent, the test figures of 92 per cent leave very little for radiation and unaccounted-for losses.

Yet there is still ample room for improvement, particularly in the more general application of existing knowledge and methods. While steam may be produced regularly at efficiencies of 90 per cent and higher, the average efficiency of all steam-generating apparatus is far below this figure, and the greater strides in the future will be made not so much in the improvement of the present best methods as in adoption of these methods by a larger portion of the fuel-using industries. —George A. Orrok in *Mechanical Engineering*.

Power Plants for Lake Tankers

THE internal-combustion-engine-driven generators shown in the figure will furnish power for auxiliary purposes on tankers and barges operated by the Lake Tankers Corporation. These Winton engines drive General Electric generators rated 50 kilowatts.

On the self-propelled tankers these small power plants will furnish electricity for miscellaneous auxiliaries and lighting; on the barges their principal duty will be to supply power to the electric pumps.



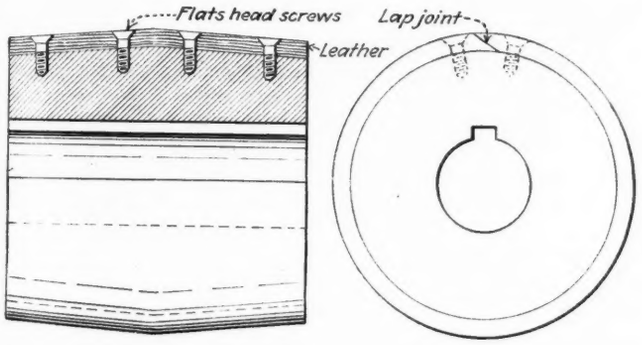
Engine-driven generators rated at 50 kw.

. . . RIGHT OUT OF THE PLANT . . .

Attaching Leather Lagging to a Small Pulley

IT IS sometimes necessary to use an unusually small pulley on motors. Where they are made of steel or cast iron there is often considerable belt slippage due to the small arc of contact with the belt. It is possible to overcome this to a large extent by covering the pulley with leather. This is frequently done on pulleys of larger diameter without much difficulty, and there are several good methods of securing the leather to the pulley. But on extremely small pulleys these methods do not apply so well.

The method shown in the sketch is one of the best I have used for small pulleys. After cutting the leather to the proper length, the ends are beveled to form a lap



Lagging is fastened to pulley by two rows of flat-head machine screws

joint. The lagging is then wrapped tightly around the pulley and tied with wire or stout cord. Then two rows of holes, three or four holes in each row, are drilled in the pulley about ½ in. from the edge of the lap. The holes are tapped and flathead machine screws are inserted. These are drawn down, then filed smooth.

Syracuse, N. Y. H. L. WHEELER.

Adapting the Boiler Room Bonus to the Industrial Plant

REFERRING to the article by W. A. Schwerin in the May 20 number on "Adapting the Boiler Room Bonus to the Industrial Plant," it is my opinion that his plan is not practical, or even fair, for any boiler room crew. By deducting 0.74 gal. of oil from the lowest previous attainable record of 5.74, the crew would have to reduce its best record by 12.89 per cent before any bonus would be paid. At 74 per cent efficiency they buy 19,000 B.t.u. for each 14,060 B.t.u. realized, this arbitrary reduction will call for 84.9 per cent boiler efficiency as shown $\frac{14{,}060}{19{,}000 \times (100 - 12.89)} = 84.9$.

The crew should be paid a 25 per cent bonus for bringing the efficiency of an ordinary boiler from 74 per cent up to 84.9 per cent. Unless there is ample opportunity for men outside the boiler room to reduce the amount of steam used per unit there is little prospect of the boiler room crew's receiving any bonus. Unless the boiler room equipment is of the highest grade, the company should be well satisfied if the firemen do not exceed the amount of oil scheduled per unit of output.

Springfield, Mass. A. L. SHEEHAN.

Fuel for Pulverized-Coal Installations

IN THE July 8 number of *Power* C. H. Camp's article on "Selecting Fuel for Pulverized-Coal Installations" may give the impression that a high-grade dry bituminous coal is essential to satisfactory and economical operation. It is true Mr. Camp mentions that for each plant there is a definite range of coals that can be burned successfully, but he emphasizes the necessity for a "good" coal.

There is no question whatever but that a poor grade of coal, with ash fusing at a low temperature, will bring disastrous results to a furnace that has not been built for it; but what engineer nowadays would try such a reckless experiment in an existing furnace, or would design a new furnace without considering the poorest type of fuel available as the basis of his design?

Modern pulverized-coal furnaces have been designed to take care of virtually any type of fuel, and it is doubtful whether one can detect more than 2 or 3 per cent difference between the efficiencies obtained with these different fuels if the furnaces and the ways of firing have been correctly studied in each case.

In Europe lignites and low-volatile bituminous coals are fired in pulverized form under hundreds of boilers of all types. In this country anthracite, semi-coke, petroleum coke, coals having an ash-fusion temperature as low as 1,600 deg. F., and in direct-fired installations a moisture content around 10 per cent, are being used in everyday practice with excellent results.

Of course, correct cooling of the furnace by air or water-cooled tubes, bare or protected by special blocks, correct location of the burners, a reasonable amount of

preheating of the combustion air, and good turbulence, are all factors that will help obtain the best results. A careful study of the problem and of the saving accomplished by using a cheap fuel at good efficiency will determine just how far it is sensible to go in the first cost of an installation.

In modern practice, one is justified in saying that the principal advantage of pulverized-coal firing is, that any type of coal can be burned in this form with satisfactory results providing the engineers have not lost sight of what the fuel specifications mean to their design.

Harvey, Ill. R. J. BENDER.

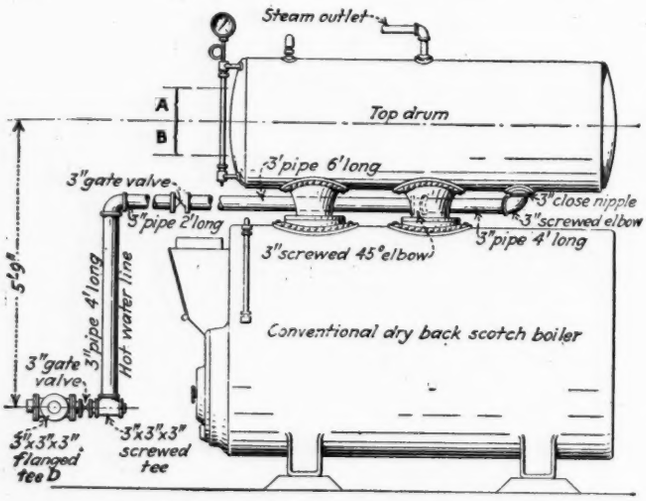
Why the Difference in Flow With Slight Change of Head?

I HAVE READ the article by P. L. Ulrich in the July 1 number, in which he requests opinions as to why the rate of flow of water varies out of proportion to the reduction of head at two levels in the drum of his special test boiler [reproduced herewith].

An explanation might be found by comparing the process of removing water from the bottom of the drum to that of removing steam from the top of a locomotive boiler. To clarify this explanation a drawing of a locomotive boiler is shown.

The water in this boiler is carried a minimum of 5 in. and a maximum of 14 in. over the crown sheet. The permissible variation in water level is shown by the cross hatching on the drawing. Steam is removed from the boiler through the throttle opening 2½ in. below the top of the steam dome, as marked on the drawing. This removal of steam from the top of the boiler is an exact reversal of the removal of water from the bottom of the drum under discussion.

On various occasions it has been determined that carrying the water at the upper limit at the top of the water glass causes an increase in the amount of moisture

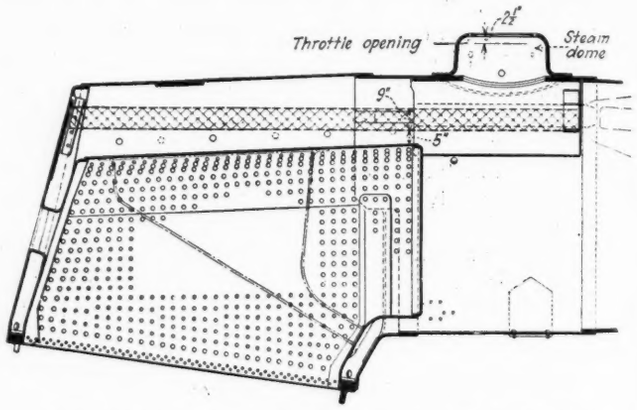


Arrangement of test boiler shown in Mr. Ulrich's article

in the steam compared to carrying the water at the lower limit in the bottom of the water glass. This has been proved by calorimeter readings of the wet steam, and drop in temperature of superheated steam. At times it is serious enough to affect cylinder lubrication through wet steam carrying off the oil. Steam passing from the higher water levels does not free itself of moisture to the same extent that steam passing from the lower water levels will.

It seems probable that a similar condition obtains in the case of removal of water from the drum under discussion, and as the water level in the drum drops the water does not have the same opportunity to free itself of steam as it does at the higher levels.

At atmospheric pressure water occupies 0.0167 cu.ft. per pound, while steam occupies 26.79 cu.ft. per pound. Steam is 1/1600 as heavy as water. If the water drained from the tank, with the level at *B*, entrained but one part in ten thousand by weight of steam (more than that entrained when water is drained with water level at *A*), the specific gravity of the mixture would



Cross-section of locomotive boiler, permissible water level variation indicated by cross-hatching

be 16 per cent less, and for the same velocity of flow 16 per cent less water by weight will be delivered.

At 140 lb. gage pressure water occupies 0.0181 cu.ft. per pound, and steam 2.922 cu.ft. In this case steam is 1/160 the weight of water, and it will take 1 part in 1,000 by weight of steam to affect the volume of water 16 per cent. At 300 lb. this ratio drops to 1 part of steam to 800 parts of water by weight to affect the volume of water 16 per cent. However, in the case of the locomotive, we find that the rapid generation increases the amount of moisture carried over by the steam. Similarly, the higher rates of delivery from the drum at higher boiler pressures do not allow as much time for the water and steam to separate, and a greater proportion of steam will be carried over. Also, at the higher pressures the specific gravities of water and steam approach each other, and separation is not as rapid.

S. H. ACKER, *Ass't Engineer of Tests,*
Springfield, Mo. St. L. & S. F. Ry.

✦

THE DECREASE in flow of water is not entirely due to the decrease in head pressure. If Mr. Ulrich will take into account the vortices that form on the surface of the water when the level reaches and falls through *B*, his designation of the water level in gage glass, and if due allowance is made for the amount of surface gases drawn through the hole of the vortex into the discharge pipe with the water, I think he will see why the rate of discharge is markedly different when the column of water is falling through *B*.

WILLIAM ANDERSON.
Brooklyn, N. Y. E. W. Bliss Co.

The Cold-Water Test on Boilers

REFERRING to the interesting letter by Eugene P. Kiehl in the July 15 number on the subject of "Cold-Water Test on Boilers," it has been my opinion for a long time that pressure tests on hot boilers would be decidedly superior to mere pressure tests on cold boilers.

Not so many years ago I witnessed some tests on pressure vessels which had been entirely welded, no rivets being used. The vessels were about 3½ ft. in diameter by 30 ft. long. In actual operation they were subjected to a pressure of about 200 lb., alternating with a vacuum. When under pressure the vessels were hot, and when under vacuum they were cool.

In the tests these vessels were filled with cold water at a pressure of about 500 lb. There was no leakage. Then a mechanic was instructed to do some pounding with a sledgehammer at different points on the vessel. This pounding, I presume, was supposed to duplicate the effect of heat. The tests were pronounced "successful."

I was assured by this manufacturer that all pressure vessels he made were tested by this method and that every one tested them in the same way. In fact, the letter by Mr. Kiehl indicates that they are still being tested by that method.

A suggestion I have made a number of times is this: Use a salt solution of water—a salt which has a melting point slightly lower than the temperature under which the test should be made. As is well known by heat-treating experts, there are many commercial salts on the market which have various melting points. By filling the pressure vessel with the proper liquified salt at a temperature of 500, 600, 700 or 800 deg., or any other desired temperature, there would be no violent explosion in the event of a serious leak. The pressure and temperature of any boiler could be duplicated perfectly under tests like these. In fact, the test pressure and temperature could both be higher than working temperature and pressure and even then there would be no danger involved. There would be no formation of gas or steam. The possible disadvantage, perhaps, would be the greater cost of the test solution. However this expense should be no great burden to a boiler manufacturer, as he could use the same solution over and over. There would be little loss or waste, if the testing were properly handled.

I might also add that one of the vessels tested as described in the foregoing did not last long in actual service. One of the seams opened and a bad ammonia leak resulted. There was no explosition, but the owner later decided to change over to another system and abandon the welded tanks. W. F. SCHAPHORST.

Newark, N. J.

✦

IN MY opinion, a hydrostatic test is necessary to show up leaks or other weaknesses often not noted by visual examination or hammer test. When applied by the plant engineer the test should not exceed the safe working pressure of the boiler. An experienced inspector is the best judge of when to use a higher pressure. Unless the state laws specify a 1½ safe-working-pressure test, under ordinary conditions the inspector will in many cases be satisfied with a test equal to the working pressure.

It is a proved fact that hydrostatic tests with cold water are unduly severe and should be applied only when necessary. A test by the plant engineer to check tightness of tubes or gaskets should be with warm water, and should not exceed the normal setting of the safety valve.

Some cases when a full 1½ hydrostatic test should be applied are at the shop when the boiler is built; at a plant when the boiler is erected; after major repairs, such as patching shell of horizontal-tubular boilers; and where a building has burned over a boiler, subjecting it to undue heat. After a test a boiler should be drained and a complete internal inspection made for broken rivets, stays, etc. Valves and fittings should also be examined to see that they have not been damaged. If safety valve was clamped, the clamp should be removed and the valve tried by hand to be sure it works freely. This should be done when the pressure has been reduced to slightly below normal and before it is taken off entirely.

If joints cannot be kept tight by calking, I believe it is practical to weld the calking edge, provided the boiler is of standard construction and otherwise in good condition. Of course, where there are state laws governing these conditions, those rules should be followed in all cases.

Another condition which is not given the serious thought it deserves is the practice of continually filling a boiler with cold water while the brickwork is hot, in an endeavor to cool off the boiler more rapidly. The proper way is to draw the fires, leave the fire door and damper open, with water in the boiler until brickwork is cool. Then draw off the water. M. C. NYE.

Stratford, Conn.

✦

CONSIDERED alone, apart from any other method of test or investigation that may be applied to steam boilers, I do not believe the hydrostatic test of any real value except that it shows whether at the time of the test the boiler to which it was applied did or did not successfully stand the test. Of course, it will also show up any leaks that exist and thus indicate what repairs should be made. But as far as real safety is concerned the hydrostatic test alone is not a sufficient guarantee, as the following will show.

Some years ago I took charge of a small railway power station in which there were two 2,500-sq.ft. water-tube boilers. I joined the station at the time of the annual test of the boilers, and before I had had the opportunity to make an examination of them the hydrostatic test was applied by the regular inspectors of the city staff, and each boiler successfully responded to 150 lb. pressure, which allowed us to carry a working pressure of 100 lb. As far as this test was concerned everything appeared to be "safe and sound." However, shortly after, I made a personal inspection of the boilers, both internal and external, and found in the case of each that water leaks at the back ends of the tubes, in conjunction with the hot sulphurous gases, had formed a corrosive agent, with the result that the tube ends close up to the boxes had been reduced to almost paper thickness. Of course, new tubes were ordered and put in as quickly as possible.

The hydrostatic test is O.K. as a supplement to a close personal inspection, but alone it does not fulfill all requirements. CHARLES J. MASON.

Brooklyn, N. Y.

From Among Readers' Problems

Conducted by
L. H. MORRISON

OVERSTROKING OF DUPLEX PUMP—*We have a 6x4x6-in. direct duplex steam pump which seems to let loose about two inches from the end of one of the strokes and strikes with considerable force with a recoil of about one inch. The valves are set correctly. How can the trouble be remedied?* R.P.

Overstroking, with pounding, probably is due to loss of cushioning steam from leakage of the piston in its covering of the exhaust port. The remedy is to provide better piston packing, or to rebore the steam cylinder and install tight piston rings. The jumping, or recoil, at the beginning of a return stroke results from the presence of air or vapor in the water cylinder, due to running the pump too fast or from attempting to pump hot water under too little head.

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DETERMINING BRAKE HORSEPOWER DELIVERED BY ENGINE—*How can the actual, or brake, horsepower delivered by an engine be determined.* R.M.C.

The friction load of an engine is practically constant for all loads. Because the brake horsepower is the net power developed, for all practical purposes the brake power delivered is the indicated horsepower when driving the unknown brake load, minus the indicated power when the engine is doing no work other than overcoming its own friction. Another method of determining the brake horsepower delivered for any indicated load is to determine the indicated power developed for various known brake-horsepower loads. Plotting the indicated power required for various known brake loads, the brake power corresponding to intermediate indicator loads is then readily determined.

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CENTER OF BOURDON SPRING GAGE—*Where is the center of a Bourdon spring gage, by which I mean the hydrostatic center, or the graphic center, or the mathematical center from which one begins to measure pressure on one of these gages when it stands vertically?* C.W.N.

Bourdon pressure and vacuum gages are supposed to be calibrated to indicate zero for atmospheric pressure exerted in the gage connection at the same level as the axis of the pivot or post which carries the gage pointer or needle. This axis is commonly referred to as the center of the gage. The indications of pressure above atmospheric pressure are assumed to be calibrated to correspond with the hydrostatic pressure that would be exerted by a liquid whose head, or height, is reckoned upward from the level of the center of the gage and, strictly speaking, when the gage tube and connection are filled with a gas or liquid of the same density as when the gage was calibrated.

For all practical purposes the calibration of pressure gages for measurement of pressure above atmospheric pressure are supposed to be true when the gage tube is completely filled with water and the connection filled to the level of the gage center; but for vacuum gages or for measurements of pressure below the pressure of the atmosphere the gage tube and connection to the level of the gage center are supposed to be filled only with air or water vapor of the density corresponding with the pressure indicated.

When a Bourdon gage is used for measuring pressures below the pressure of the atmosphere, as attached to the suction main of a pump, the reading is assumed to be true for the elevation where the gage is connected to the suction pipe, and the gage tube and connection are assumed to be filled with air at the pressure below atmosphere indicated by the gage. To assure accuracy of readings, a pet-cock should be attached to the gage pipe below the gage cock, and opened occasionally to free the gage and pipe of air when measuring pressure above the pressure of the atmosphere, and for freeing the gage and connection of water when the gage is indicating pressure below atmospheric.

The total head to be credited to a pump is found by adding together the head corresponding to the pressure shown by the gage on the pressure main, the lift corresponding to the vacuum shown by the vacuum gage and the vertical distance in feet between the center of the force main gage and the point where the suction gage pipe connects with the suction main. However, if the suction main is under pressure instead of a vacuum, the suction gage should be attached at such a level that the connecting pipe and gage tube may be filled with water when the pet-cock is opened. In that case the correction for difference in elevation of gages, which is the vertical distance between the centers of the gages, is to be added to the reading of the pressure-main gage and from that sum the pressure reading of the suction gage is to be subtracted.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

IN CHANGING from pulverized coal to natural gas, can we expect that our superheaters, which are of the convection type, will show too high a superheat? The highest superheat we can carry, on account of the engines, is 100 deg. F. with steam at 200 pounds. A.C.B.

FLUE GAS analyses from a thousand different boilers, and the results from the same boilers after changing the conditions, prove conclusively to me that when burning gas with from 15 to 50 per cent excess air, either delayed or incomplete combustion usually results. If the primary air supply in a Bunsen-type burner is decreased when the secondary air is reduced by the damper, if the air and gas are stratified by regulating the air supply to the burner port of a free-flame burner, if the gas stream is so large that immediate contact of all the gas with the air is delayed in any type of burner—in all those cases excess air increases the

flue temperature, unless delayed combustion exists, in which event it usually decreases the flue gas temperature.

Visible delayed combustion is infrequent with pulverized coal, and therefore in making a comparison it would be necessary to assume that the natural gas would be used with no more excess air than the pulverized coal, and that delayed combustion would not exist. This is possible in all cases where pulverized coal has been used, unless the front of the boiler is so small that the gas cannot be introduced in fine enough streams to allow immediate contact with the air. This is governed by the load and gas pressure available.

The only opportunity I have had to make a direct comparison of pulverized coal with natural gas was not on the above basis, as the flue gas analyses showed that combustion was incomplete and the fire was similar to other cases where delayed combustion had been proved. In this case the flue gas temperature with natural gas was 750 deg. F., where it had been 600 deg. F. with pulverized coal. A free-flame burner was used and the air supply to the burner ports was regulated. As the management was satisfied that 8.5 per cent CO_2 in the flue gas made for efficient combustion, no changes were made in this installation. But to leave the air to the burner ports unrestricted and regulate the supply by the damper has effected a reduction of 250 deg. F. in other similar installations.

Although some authorities state the opposite, I believe that the per cent of heat transmitted to the heated medium by radiation is greater with natural gas than with coal; this is due to the fact that the actually observed temperatures of flue gases in the first pass have been a lesser per cent of the maximum flame temperature in natural gas installations than in coal installations, and also the last-pass temperatures have been lower.

The temperature of superheat in a superheater of the convection type should vary directly with the temperature and amount of the flue gas. Therefore the superheat should be lower with natural gas than with pulverized coal, because the amount of gas is nearly the same and the temperature will be lower with natural gas. M. M. BUTLER.

Casper, Wyo.

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NATURAL GAS, when properly mixed with air in the burner cone, burns with a shorter flame than it is now possible to obtain with pulverized coal. Combustion is complete in a shorter gas travel and burning, if any, in the second pass is less than with pulverized coal.

Because of this more efficient combustion and the fact that the excess air can be carried at a smaller percentage, lower temperatures and velocities at the superheater obtain at the same rating when firing natural gas. This results in a lower superheat.

GRANT HARRIS,
Continental Motors Corporation.
Muskegon, Mich.

FLAME PROPAGATION of pulverized coal is fairly slow. A long flame travel is necessary for complete combustion. Average practice, even with a large furnace volume, allows the flames to lick the lower rows of boiler tubes, with a resulting high gas temperature past the superheater tubes. In the case of natural gas, however, flame propagation is rapid and combustion is completed within a few feet of the burner. Hence no combustion takes place near the lower row of tubes, with resulting gases passing the superheater tubes being much cooler then those in the pulverized-coal fire.

When burning pulverized coal 20 to 25 per cent excess air must be used to obtain complete combustion and maximum efficiency. With natural gas only approximately 10 per cent excess air is required. This reduction of excess air will also lower the degree of superheat.

Assuming, then, that no change is made to the size of the furnace and gas burners are substituted for coal burners, the degree of superheat will be lower when firing natural gas then it will be when firing pulverized coal.

San Antonio, Texas. C. G. KRAUSE.

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IT IS NOT likely that there will be any appreciable or serious difference in superheat in view of the fact that the superheater is of the convection type and is therefore protected by boiler tubes. In fact, it is safe to say that in most instances the superheat will be lower with natural gas than with pulverized coal. According to one combustion authority, the boiler exit temperature is highest when blast-furnace gas is used; next comes Texas lignite, followed by Illinois bituminous; and natural gas is last.

If natural gas produces higher furnace temperature than pulverized coal, most of the extra heat will be absorbed as radiant heat by the tubes "in sight of the flames." But it is not likely that the furnace temperature will be as high with natural gas.

In spite of my belief that the superheat will not be higher, it is usually possible to cut superheat down by making an alteration in the baffling of the boiler. I have in mind a boiler-baffle engineer who can produce almost any superheat temperature desired and who has effected surprising economies in boilers that were previously inefficient and uneconomical. Whenever radical changes are made in the combustible it is sometimes advisable to make alterations in the baffling.

W. F. SCHAPHORST.

Newark, N. J.

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WHEN changing from pulverized-coal firing to natural gas an increase in superheat will be obtained with convection superheaters. The amount of increase will depend on the design of the boiler and furnace, and location and design of the superheater.

Natural gas burns with little or no flame, so that the amount of radiant heat given off is considerably less than when burning pulverized coal or oil. Thus the radiant heat loss through the boiler settings and the radiant heat absorption in the lower rows of tubes in the first pass will be considerably reduced, resulting in a higher temperature of gases entering the superheater, and, correspondingly, a greater heat transfer in the superheater.

If the installation contains water wall tubes instead of refractory material, the increase in superheated steam temperature when changing to natural-gas firing will be even greater, because of the reduced heat transfer in the water-wall surfaces.

In some installations it is possible, by means of baffling, to change the direction of the gases or increase their velocity so that the heat transfer will remain the same. In many cases this is more expedient than removing some of the superheating surface, and it accomplishes the same result.

K. P. KAMMER
New Orleans Public Service Inc.
New Orleans, La.

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IN CHANGING from pulverized coal to natural gas under the usual design conditions, it may be expected that higher superheat will result with a convection type of superheater, because a healthy gas flame is blue, while a pulverized-coal flame is white to yellow.

The gas flame would not, therefore, radiate as great a proportion of heat directly to the heating surface as the pulverized-coal flame. This would leave a greater percentage of heat absorption to be taken care of by convection in the boiler passes, so a convection heater would absorb more heat when the boiler was operating on gas.

However, there are many other conditions which could influence the results, such as location of superheater; design of baffles, which might be modified with the changeover; use of refractory targets or checkerwork to increase incandescence; and direction of the flame against the heating surfaces.

R. S. LANE, *Mech. Eng.*,
Pocahontas Fuel Company, Inc.
New York City.

A Question for Our Readers

OUR 5-stage, turbine-driven centrifugal boiler-feed pump at times rumbles and vibrates badly. What is the cause?

A.B.D.

Suitable answers from readers will be paid for and published in the Oct. 14 number

Progress of Low-Temperature Carbonization in Great Britain[1]

By Dr. C. H. Lander[1]

IN ANY system of carbonization of coal a certain proportion of the heat value is necessarily lost in the process. This loss can be made good, and the costs of the process covered, only if the results of the process can be used more conveniently, or with greater efficiency than the raw coal. The products of all types of carbonization are gas, coke, tar, and ammoniacal liquor, and some light hydrocarbons can be scrubbed from the gas. If of sufficient strength the liquor may have some value as a source of ammonium sulphate. In general, however, where the carbonization takes place at temperatures below 1,000 deg. C., the liquor is too dilute and becomes a liability rather than an asset.

While tar can be used as a fuel or source of fuel, or for other purposes, it amounts to only some 10 per cent of bituminous coal. It must therefore in every case be considered as a byproduct of the process rather than a main product. The quality and quantity of the tar depends on the character of the coal, the temperature of carbonization, and other factors.

The main products of carbonization are gas and coke. In the gas industry gas is the main product, and there is a tendency here to increase gas yields at the expense of other products. In the metallurgical coke industry, coke is the main product, and the process must be directed to produce a coke of the required quality. The main products in both these industries are necessary for certain purposes, and within a fairly wide range the selling price can be adjusted to meet the cost of manufacture.

Price Unrelated to Production Cost

Low-temperature carbonization differs from the processes used in the gas and coke-oven industries in that it yields no product for which there is any considerable and steady market, and which is not, at the same time, in direct competition with some other product the price of which is quite independent of the industry itself. The chief product, amounting in the case of bituminous coals to some 60 to 80 per cent of the weight of the coal treated, is undoubtedly the coke. This coke forms an excellent fuel for many purposes, but it is, in most cases, in direct competition with raw coal, and this fact will determine the maximum price for which it can be sold.

In much the same way the price obtained for the gas will depend on the cost of equivalent fuel. If it can be used for town's supply, it may be worth the cost of producing gas under similar conditions of demand by ordinary gas-works practice. If, on the other hand, the gas can be used only for heating the retorts, or similar purposes, it can be credited only with the price per therm equivalent to alternative fuels, such as low-grade coal or coke breeze.

It follows from the facts set out above that the price obtainable for all the products of low-temperature carbonization must depend on the available markets and the cost of alternative fuels, and that there is no product the price of which can be adjusted according to the costs of manufacture.

Fundamental Factors

Before any estimate can be made of the commercial success of the process, it is necessary to know:

1. The type of coal available, and its cost.
2. The type of products for which there is a local market, and the prices obtainable.
3. The type of plant that will yield suitable products from the available coal and in the most remunerative proportions.
4. The costs of erecting and working the plant.

These considerations are general, but their application differs greatly in different countries and in different parts of the same country.

In most cases the main object of low-temperature carbonization is either to produce an improved solid fuel, or to obtain as much oil-producing tar and spirit from the coal as possible before the coal is burned in the furnace, for which the raw coal could be used without treatment.

Where an improved solid fuel is the main consideration, the governing factors are the type and price of the available coal, and the type and price of the alternative fuel with which the improved product is to compete. In Great Britain the main object, from a broad national point of view, is the production of a smokeless free-burning solid fuel for use in the open domestic grate, for other domestic uses, and for smaller industrial plants.

Depending on the process of carbonization, the calorific value of the gas may vary from 1,000 B.t.u. per cubic foot to less than 200 B.t.u. per cubic foot. Those processes that treat the coal by external heat, in closed retorts, will produce from 20 to 30 therms of gas per ton at a calorific value of 1,000 B.t.u. per cubic foot. Introduction of either steam or air into the retort will generally increase the thermal yield and reduce the calorific value. Processes which treat the coal by internal heating necessarily produce large volumes of gas of low calorific value.

Broadly speaking, it may be said that those processes which produce a coke suitable for domestic purposes, and a gas suitable for distribution, are most suitably worked by, or in close co-operation with, a gas undertaking.

[1]Digest of a paper presented on June 1 before the Second World Power Conference in Berlin.

Evolution of the Marine Boiler

DENIS PAPIN, in 1707, applied steam to drive a model boat on the Fulda at Cassel, Germany. He is given the credit also for having first made use of, in 1860, the lever type of safety valve to control the pressure of steam, according to the *Generator*.

John Fitch adopted a "pipe boiler" in his boat of 1787; it consisted of a small water pipe, winding backward and forward in the furnace, one end terminating at the point where the feed water entered, the other uniting with the steam pipe leading to the engine. The name of Voight was that of a Dutch watchmaker, Henry Voight, a good mechanic and a very ingenious man.

Barlow's water-tube boiler was used in Robert Fulton's second steamboat on the River Siene, France, in 1803. (His first boat broke in two and sank.) It was probably safe for the pressure commonly employed at its time—3 to 7 lb. per square inch.

In 1804 Colonel John Stevens built and operated on the Hudson River a little steamboat 68 feet long by 14 feet wide. Steam was supplied by one water-tube boiler containing 100 tubes 2 in. in diameter and 18 in. long. One end of each was fastened to a central water chamber, the other end being closed. The hot gasses passed around these tubes, the water being inside of them. It was built for a working pressure of 50 lb. per square inch, which was a definite advance in high-pressure steam-generating apparatus.

In 1824 John Babcock patented a "pipe boiler," the pipes being of cast iron. Water was injected into the hot boiler as fast as required to furnish steam, no water being retained in the steam generator. This boiler was first used in a boat called the Babcock, built at Newport, R. I., in 1826.

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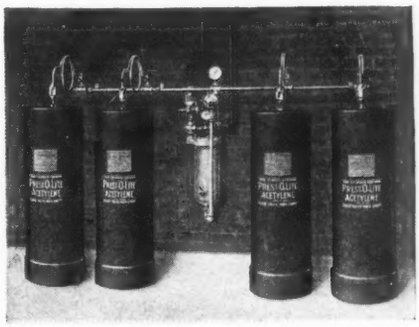
Turbine-Generator Exports Up—While exports of electrical machinery and apparatus in July were valued at $2,600,000 less than the exports in July of last year and were $1,000,000 less than those of June, the decline is by no means general throughout the list. Over 500 steam turbine-generator sets were exported in July of this year, compared with 12 of last year. Accessories and parts for generators increased, as did arc-welding sets, instrument transformers, switchboard panels, circuit breakers, and small motors.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES



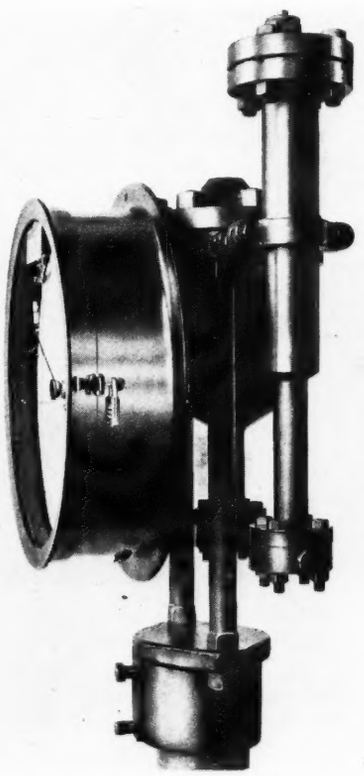
Six-cylinder oxygen and four-cylinder acetylene manifolds

Flow Meter and Flow Controller for High Pressure

AS A SUPPLEMENT to its line of high-pressure flow meters and flow controllers for 5,000 lb. application brought out about a year ago, the Foxboro Company, Foxboro, Mass., has introduced a new recording flow meter and flow controller for operating pressures of 2,500 pounds.

A single-pen instrument is illustrated. If static readings are needed a two-pen instrument with static element is furnished. Where total flow readings are desired an integrator can be supplied on the instrument. The integrator gives flow readings without the use of multipliers.

All parts are designed for high-pressure application and all working parts are drop forgings. The flow meters, also the flow controllers, can be mounted in place, without loading devices.



Flow meter for 2,500 lb. pressure applications

Oxygen and Acetylene Manifolds

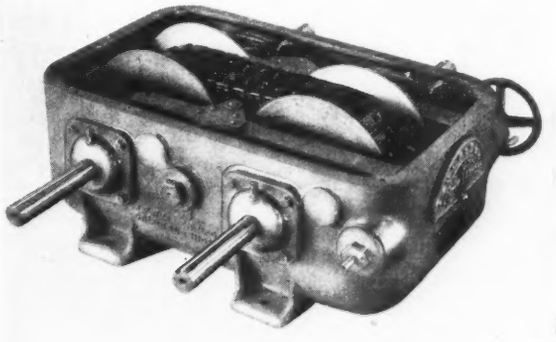
TO MEET the need for a convenient means of gas distribution where it is necessary to have a number of welding stations and the consumption of gases is not large enough to warrant the installation of an acetylene generator, the manifolds illustrated have been introduced by the Oxweld Acetylene Company, 30 East 42d St., New York City.

The six-cylinder oxygen manifold shown in the upper view is of the wall type and is arranged so that three cylinders may be changed while the bank of three on the other side is maintaining the supply of oxygen.

The four-cylinder acetylene manifold shown in the lower view is also of the wall type. Each cylinder lead has a valve in the header, so that each cylinder is independent of the others. This makes it possible to use either one, two, three, or four cylinders at the same time, so that a cylinder may be readily replaced.

Improved Variable-Speed Transmission

COMPACTNESS and the adoption of ball bearing and pressure lubrication throughout are features of the series 100 variable-speed transmission put out by the Lewellen Manufacturing Company, Columbus, Ind.

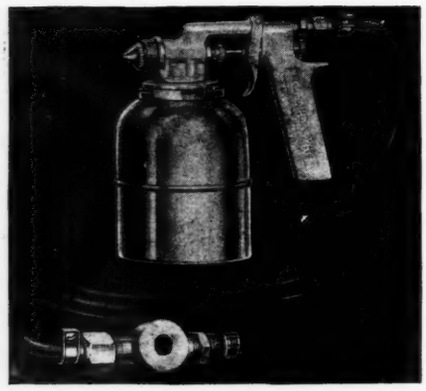


Unit may be run in either direction and either shaft may be used for as the variable or constant speed

The inclosing case is water- and dust-tight, and access to the interior is had by removing the one-piece

cover, which is bolted in place. Ball bearings carrying the two main shafts are bolted in place on the side as shown. Variation in the speed of the driven shaft is effected through a handwheel mounted on side. At one end an indicator shows the various positions between maximum, high, and low speeds.

This series is available with drive motor support and remote control. It may be supplied in regular speed ranges, and may be run in either direction, mounted in any position and either shaft may be used as the variable or constant speed shaft.



Spraying unit that can be operated by compressed air from a gasoline engine

Paint-Spraying Units

TWO OF FOUR units included in a complete line of paint-spraying outfits now being put out by the Binks Manufacturing Company, 3114 Carroll Ave., Chicago, Ill., are shown in the illustrations.

The portable unit illustrated has a 2-gal. pressure material container, and the air compressor has a displacement of 3.5 cu.ft. of air per minute. The other units in the line include two hand-spray guns with small-capacity containers, and one larger unit with a 5-gal. container. Each of the outfits is designed to operate with compressed air produced by attaching a hose to the engine of a truck or other unit. One or more spark plugs, as required, are removed and special air pressure valves, with hose attached, are inserted. With the small hand gun one cylinder is used, and with larger units two cylinders are employed. This feature permits the gun to be employed on jobs in isolated places where current may not be available.

In each outfit the material is syphoned to the nozzle of the gun and discharged in a flat spray.

Roller Chain Drives

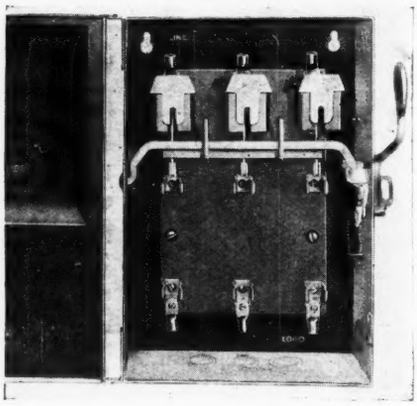
THE Diamond Chain & Manufacturing Company of Indianapolis, Ind., has announced a new stock drive for power applications, as illustrated, consisting of roller chain and two sprockets, ready to be installed. They are carried by distributors in single to quadruple strands, having capacities from $\frac{1}{4}$ to 75 hp. in ratios up to 8.4 to 1 and for motor speeds up to 1,750 r.p.m. This supplements the company's regular line

Three-strand roller-chain drive

of high-speed drives available in capacities up to 672 hp. and speeds up to 3,600 revolutions per minute.

Safety Switch With Arc Quenchers

COMPACTNESS without sacrifice of ample wiring room or sufficient voltage spacings features a new line of quick-make and quick-break safety switches designated type WK-97 introduced by the Westinghouse Electric & Manufacturing Company, of East Pittsburgh, Pa.

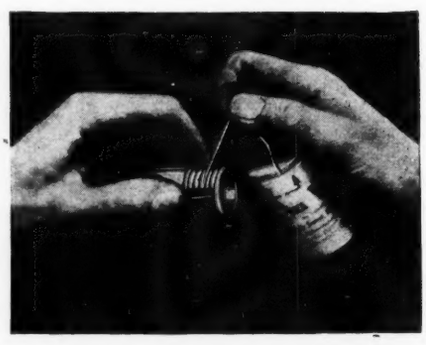


Open view of safety switch equipped with De-ion arc quenchers

This line incorporates the "De-ion" arc quencher on the 575-volt sizes. The quenchers consist of nickel-plated, slotted steel plates held in place by insulating holders and mounted individually over each jaw. All copper parts of the switch are removable from the front of the base. The use of diamond-pointed break jaws and extended blades is said to assure clean contacts and prevent burning and beading of contact surfaces. Crank bearings are dust-proof, with grease packing, and lock-on and lock-off brackets are provided.

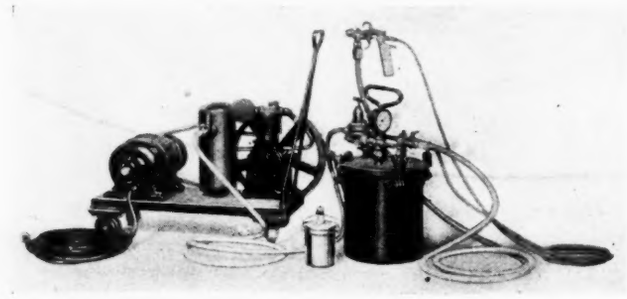
Wicking for Use on Brass Threads

TO OBVIATE the necessity of drawing fine strands of wicking from a larger roll when threading and fitting brass piping, Quick Products, Inc., 972 Broad St., Newark, N. J., has made available wicking of the proper size on a spool ready for



Wicking is wound on threads directly from carton

winding on the pipe, as shown in the illustration. It is furnished in three sizes, No. 1, for use on pipes up to $\frac{3}{4}$ in. diameter; No. 2, for pipes from 1 to 2 in.; and No. 3, for use on pipes from $2\frac{1}{2}$ to 4 in. diameter



Self-contained unit with motor driven compressor and large material container

NEWS of the FIELD

Spot News

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SWEPT *by a spectacular fire, the Federal Trade Commission Building in Washington was thoroughly gutted Aug. 30, but fortunately few important papers were lost. Although many of the files were water soaked or scattered in hasty removal, it is believed that the public utilities probe, interstate power survey, and other nation-wide investigations can be resumed without irreplacable losses after some little delay.*

•

UNDAUNTED *by two failures, Georges Claude, the French scientist who is attempting to extract power from the difference in temperature between the surface and bottom of the tropical ocean near Matanzas, Cuba, is nearly ready to try again. His third mile-long, 6-ft. corrugated iron pipe is virtually completed, and an attempt will be made shortly to sink it to the bottom of the sea.*

•

CONTRACT *for three 50,000-kw. steam turbine-generators, at a cost of $2,000,000, has just been placed with Parsons & Company of England by the Newcastle Electric Supply Company. These units are required in connection with the changeover to the national grid standard of frequency in the northeast coast area of Great Britain. It is estimated that the changeover in this territory will involve an expenditure of $50,000,000.*

•

A LICENSE *for a 283,000-hp. hydro-electric development on the Klamath River, Ore., to be built by the California Oregon Power Company was granted recently by the Federal Power Commission. Construction work on the first 50,000-hp. unit, costing approximately $5,000,000, will be started at once.*

Symposium on Testing of Welds a Feature of Welding Society Fall Meeting

Other subjects to be discussed at Chicago, Sept. 22-26, include pressure vessel welding, X-ray inspection and welding costs

IN LINE with its purpose of placing welding on a sound scientific basis, the American Welding Society has made testing and standards a major theme of its fall meeting, to be held at the Congress Hotel in Chicago, Ill., from Sept. 22 to 26, inclusive. Under the sponsorship of the American Bureau of Welding, the research organization of the society, a symposium on the testing of welds will be presented at the technical session on Wednesday afternoon to further a revision, which is now under consideration, of the present standard tests.

Experience and advancement of the art since the first standards were issued have shown the need for revision, according to the bureau. Three standard tests are proposed, namely, tension, bending, and shear. Impact and fatigue tests are desirable where complete information is wanted. Various types of standards for each of these tests have been proposed and will be discussed at the session.

The symposium will deal not so much with opinions as with actual results obtained from the use of the various standards suggested. Included among the papers scheduled for presentation at the symposium are: "Tensile Tests for Welds," by J. W. Owens; "Bend Test for Welds," by W. B. Miller; "Shear Tests for Welds," by A. Vogel; "Impact and Fatigue Tests," by C. H. Jennings; and "Special Methods of Investigation," by G. E. Doan.

Closely allied with the symposium are the following papers, which will be given at the technical sessions on Tuesday and Thursday afternoons: "The Examination of Welds by the X-Ray Diffraction Method," by J. T. Norton; "Fatigue Investigations of Welded Joints," by G. E. Thornton; "Stress Distribution in Side-Welded Joints," by Walter H. Weiskopf and Milton Male; and "Magnetic Testing of Butt Welds," by T. R. Watts.

Of great interest to engineers in the power field is the monograph, on "Application of Fusion Welding to Pressure Vessels," which J. C. Hodge will present at the technical session on Thursday afternoon. Expected to be an outstanding contribution to the subject, this paper will describe a series of investigations and developments based upon the results of the work carried on by the Babcock & Wilcox Company.

A paper that should appeal to all users of welding is Robert E. Kinkead's "Cost of Using Welding," to be given at the technical session on Wednesday morning. In this study Mr. Kinkead will advance the thought that the labor, material, and overhead factor is an inadequate indicator of real costs in the case of welded products, and that absolute cost in an economic sense involves service behavior and life of the product. He will show how scientific prediction of these factors may be made to obtain "the cost of use," the cost management is really interested in.

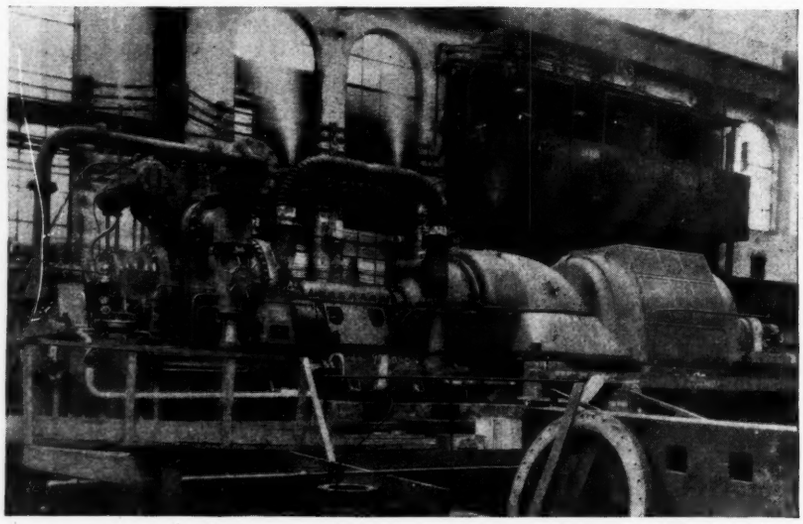
Throughout the meeting a welding exposition will be held at the Stevens Hotel, where the latest machinery, accessories, and materials used in welding will be on display. A full complement of entertainment features include a trip to the Hawthorne Works of the Western Electric Company, sightseeing trips, luncheons and dinners.

Court to Decide Location of Rio Grande Plant

Until the United States Supreme Court hands down a final decision as to whether the Rio Grande power plant of the El Paso Electric Company is in Texas or New Mexico the company will withhold payment of taxes, according to announcement of F. J. Gannon, president.

The power plant is situated on a strip of land claimed both by New Mexico and Texas. The land, lying along the Rio Grande and north of El Paso, was awarded to New Mexico in a recent survey ordered by the United States Supreme Court. However, the survey has not been finally approved, and the State of Texas still claims ownership of the plant and the right to continue to tax it. The State Tax Commission of New Mexico recently assessed the property at $1,500,000. The Supreme Court is expected to convene in October to rule on the boundary.

Assembly of High-Temperature Turbine at Delray No. 3 Nearing Completion



The 10,000-kw., 1,000-deg. unit set up on test at the works of the British Thomson-Houston Company, Ltd., Rugby, England

ASSEMBLY of the British Thomson-Houston high-temperature turbine-generator is rapidly nearing completion at Delray power house No. 3 of the Detroit Edison Company. Latest reports from engineers of the company indicate that the unit will be ready early in October for turnover with steam at normal station temperature. High-temperature steam will not be available until sometime later, according to present expectations.

This unit has been under construction for two years. Though rated at only 10,000 kw., it has unusual features which make it of special interest and which made slow construction advisable. Trouble was encountered with nearly every cast part used in the high-temperature section, owing to the difficulty of obtaining sound castings from the alloy steel selected to withstand the high temperature.

The high-temperature casing was made in one piece. The diaphragms holding the steam nozzles between stages are held in place by an inner lining, or secondary casing, having a horizontal joint. The corrugated piping bends that connect the high- and the low-pressure elements are being used extensively in England for providing flexibility in steam lines where building space is restricted. The manufacturers of this piping state that the corrugated bends are five times as flexible as the same size bends made from plain pipe, which allows the use of bends approximately one-fifth as large as those now necessary for a given expansion.

The generator will be excited by two direct-connected exciters instead of the one unit customary in this country. This tends to make generator operation more stable during electrical disturbances. The generator housing has a flat top provided for the installation of quick-opening doors that are used in case of failure of the air cooler.

A Babcock & Wilcox superheater will supply high-temperature steam to the unit. The turbine will be run with station steam at 400 lb. pressure and 725 deg. F. until additional superheating equipment is installed some time in October. The superheater will be separately fired with fuel oil and will raise the station steam to 1,000 deg. F.

Device Detects Line Leaks from Airplane Patrol

Airplanes soon will be put to work generally in regular patrols of long-distance electric power transmission lines if plans now being worked out by officials of the Union Electric Light & Power Company of St. Louis prove successful. The company's new Ford tri-motor club plane, purchased primarily for carrying officials and other personnel to a site in the Ozarks, 140 miles southwest of St. Louis, where the company has a giant power dam under construction, is to be equipped with an electrical device capable of detecting power leaks from transmission lines. By flying low over the transmission lines engineers in the planes will be able to detect instantly power leaks, determine accurately at which tower the leak is to be found, and dispatch repair crews quickly to the site.

Use of the new device, developed by Earl C. Hansen, the radio engineer whose electrical pilot cable worked out for the United States Navy during the World War enabled allied shipping to safely thread a way through mine fields and mine-laid harbors, will permit a single plane, or a small fleet of planes, to replace the large forces now maintained by every power company for inspection of their transmission lines.

Company officials are so optimistic over their plans that they propose that repair parts, such as insulators packed in cartons, and repair tools, be carried in the patrol plane, ready to be dropped overboard where power leaks are found. In emergency cases they even intend to carry repair crews in the plane to the breaks in the power line and send them overboard to their work in parachutes. Enormous savings are expected from this method of patrol.

Memorial to Be Dedicated to George Westinghouse

Dedication of the memorial to George Westinghouse, inventor and founder of the industries which bear his name, will take place on Oct. 6, it has been announced by A. L. Humphrey, chairman of the Westinghouse Memorial trustees. Invitations are now being sent to hundreds of the most eminent persons in America to attend the affair as guests of honor. Leaders of industry, science, art, and education will pay tribute to the genius who conceived the air brake, developed the steam turbine, and was the proponent of alternating current, and, as well, created industrial structures to provide the world with the benefits of these vital engineering developments.

The ceremony will include the dedication and unveiling of a bronze group of heroic proportions created by Daniel Chester French, America's foremost sculptor. A banquet will be tendered to the guests in the evening.

Erection of the memorial was made possible by appropriation and subscriptions among 60,000 employees of Westinghouse industries in the United States and other countries. Its location will be the most beautiful spot of Schenley Park, Pittsburgh, Pa.

Celebrate Opening of New Line to Mexico

Emergizing a new 33-kv. line from Tijuana to Ensenada and Maneadero, Mexico, a distance of 68 miles, recently was the occasion for a celebration attended by many Mexican and federal officials and representatives of the San Diego (Calif.) Consolidated Gas & Electric Company and officials of the Southern California Telephone Company.

The line was installed by Cia. Eléctrica y Telefonica Fronteriza, S. A., which purchases its power from the San Diego utility for distribution at Tijuana and Agua Caliente and now in Ensenada.

Governor Jose Tapia of Lower California threw the switch that inaugurated the celebration.

World Power Conference Transactions Ready

Complete transactions of the Second World Power Conference have been published in Germany and will be released for distribution in this country on and after Oct. 10. The lengthy proceedings of the conference, printed in English are contained in a set of nineteen volumes and an index volume, approximately 8,210 pages. A twenty-first volume, not included in the set, contains the special reports of the conference, and may be had in English, French, or German.

Titles of the nineteen volumes in the set are: Uses of Electricity; Production and Use of Gas; The Use and Mechanical Transmission of Power; Thermal Power Plants; Prime Movers; Solid Fuels and General Power Economics; Boilers and Furnaces; Oil and Internal Combustion Engines; Water Power Plant and Equipment; Water Power Development and Legislation; Power Storage and Interconnection of Generating Stations; Electrical Machinery; Electrical Switchgear; Electrical Transmission; Problems of Load Factor, Power Tariffs and Central Station Economics; Problems of Power Supply and Legislation; Power in Transport; Research, Standardization, Statistics, and Education; General Addresses.

A special pre-publication price of $75 for the set of nineteen volumes and index volume prevails until Oct. 10. After that the set will cost $85. Volume XXI, sold separately, is priced at $7.50 before and $9.50 after Oct. 10. Any one of the regular volumes comprising the set may be purchased singly at special prices before and at regular prices after the publication date. These prices include delivery to the purchaser, but do not include duty if the latter is imposed. It is probable, however, that the books will be free from import duty. All orders and inquiries should be sent to the American Committee of the World Power Conference, 1419 Chrysler Building, New York City.

New Science Courses at Cooper Union

Research is advancing knowledge with such speed that a new center of adult education in science and engineering will be opened this Fall at Cooper Union, New York City, it is announced by Prof. Albert B. Newman, head of the Department of Chemical Engineering.

Engineers and other industrial scientists throughout the New York area recognize the need of organized study to prevent them from falling behind the developments in scientific investigation, Prof. Newman says. Members of the faculties of colleges and technical schools will also enroll in advanced evening lecture courses in chemical engineering and physics to be given at the Union during the coming academic year.

Prof. Karl F. Herzfeld of Johns Hopkins University will present a survey of the field of modern physics with the topics to be covered closely related to chemical theory. Unit operations of chemical engineering will also be studied in a course directed by Professor Newman.

Many of the major industrial achievements of the next generation, it is predicted, will be made by chemical engineers with a working knowledge of modern physics. Workers so equipped at present are rare, it is declared.

Railroads Asked to Lower Coal Rates in Gas Fight

Viewing with apprehension the snake-like advance of natural-gas pipe lines from the Southwest to Minneapolis, St. Paul and other cities in the Northwest, the Northwest Retail Coal Dealers' Association has begun efforts to have the railroads reduce rates on coal in territory where gas may be a competitor.

Letters have been sent to executives of railroads serving the Northwest coal trade suggesting a conference "to devise ways and means of protecting the coal industry from the encroachments of natural gas."

News of Canada

Construction contract awarded for 275,000-hp. Abitibi River project—Maclaren company to build third large plant on Lievre

WORK will commence at once on the $23,000,000 power project of the Hudson Bay Power Company on the Abitibi River in northern Ontario, following the announcement of the awarding of the contract to the Dominion Construction Company of Toronto. This is one of the largest public utility undertakings in the province, and the construction is expected to take about two years. The location of the power site is about 64 miles north of Cochrane, Ontario, and only a few miles from the main line of the Temiskaming & Northern Ontario Railway, from which a spur has already been built to carry construction materials to the scene of the undertaking.

The Abitibi Canyon water power will be developed under a head of 237 ft. Details of construction show that a concrete dam is to be erected on solid rock foundations, and the power house to be erected in the gorge below will contain five generating units of not less than 55,000 hp. each.

This power is to be developed for the Hydro-Electric Power Commission of Ontario and the Abitibi Power & Paper

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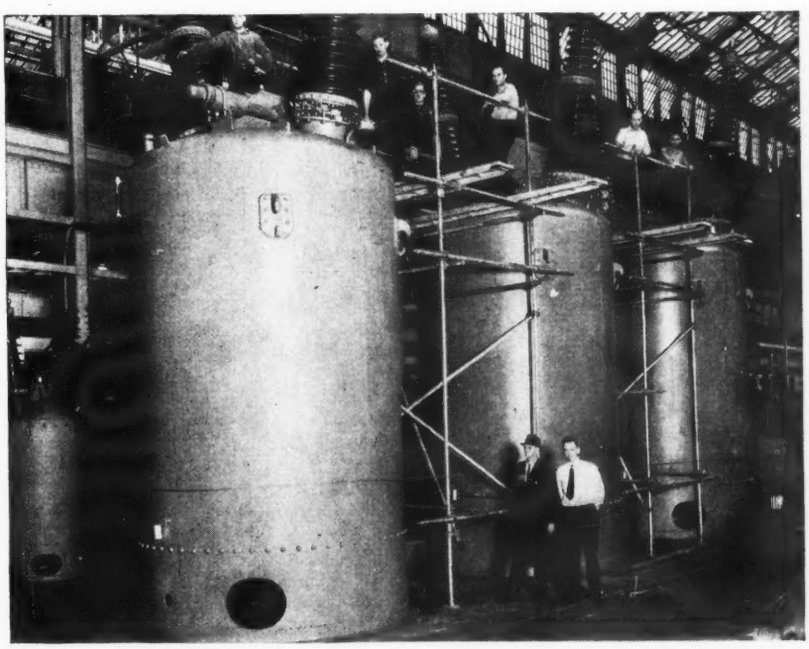
GIANT DE-ION CIRCUIT BREAKER



Equipped with the latest De-ion grid-type contacts and full automatic solenoid mechanism, this 230-kv. circuit breaker was completed recently at the East Pittsburgh works of the Westinghouse Electric & Manufacturing Company. It will be installed on the 220-kv. system of the Philadelphia Electric Company at Plymouth Meeting switching station. Because of its huge size, three underslung cars were required to transport it

Company. The hydro commission's contract runs for 40 years, 85,000 hp. to be delivered upon completion of the plant and 100,000 hp. in 1936. To deliver power at Sudbury, where an urgent demand exists in connection with nickel-copper mining operations, will require one of the longest transmission lines in Canada. The distance from the power site to Sudbury is about 250 miles. This line will be built by the hydro commission at an estimated cost of $3,500,000.

PLANS have just been announced by the James Maclaren Company, of Buckingham, Quebec, for the construction of a third big hydro-electric plant on the Lievre River, in the Province of Quebec, to cost $10,000,000 and to develop 120,000 hp. The plans submitted to the Federal Department of Public Works show that the company proposes to build a dam and intake structure across the Lievre, and to connect the intake by means of a tunnel to the power house. The dam and intake will be about 587 ft. long, with additional abutments on either side. The dam will be 425 ft. long and contain eight gates, 24 ft. wide and 20 ft. deep, and two waste gates each 18 ft. wide. The maximum elevation will be 384 feet.

The intake section will have eight openings, and with the water above the dam at an elevation of 341 ft. the dam will have a discharge capacity of 65,000 cu.ft. per second. Over the gates there will be a power house of fireproof construction, provided with electric cranes for operating gates and handling other intake equipment. Four turbines will be installed, each capable of developing 30,000 hp. The generators will be of 28,000-kva. capacity each. There will be seven outdoor-type transformers, which will raise the voltage to 220,000.

How to Improve Business, Topic of A.T.A.E. Meeting

The part of the trade association in bettering business conditions has been announced as the principal subject before the eleventh annual convention of the American Trade Association Executives, which will be held at the Clifton House, Niagara Falls, Ontario, Sept. 24 to 27. The convention will bring together managers, secretaries, and other professional executives in charge of nearly all the leading trade associations of the United States, and replies already received indicate the largest attendance in the history of the organization.

Several other trade bodies will hold meetings at Niagara Falls while the A.T.A.E. is in session. One of the most important of these is the Conference of Industries That Have Held Trade Practice Conferences. This group will meet on Sept. 25, and all trade associations interested are invited to send representatives. Abram F. Myers, chairman of the standing committee, will present a comprehensive analysis of revisions requested by the Federal Trade Commission in trade practice conference rules, and discuss the extent to which such revisions are necessary in order that the rules may be sustained by law.

The A.T.A.E. program has been arranged so that all the addresses and reports may focus upon the central theme of "better business." The keynote address will be made at the opening session on Sept. 24 by President M. L. Heminway. Arrangements are being made also for addresses by leading figures in the business world outside of the ranks of the association.

How's Business?

THE SLOW, uncertain, seasonal upturn in business from the low point at the end of July shows signs of beginning to lag alarmingly under the weight of widespread inertia of financial leadership and business initiative. After rising steadily for three weeks, our index of general business activity has fallen back sharply from 89% of normal to 86.5%, the lowest so far reached. Although steel and coal production, freight movement and currency in circulation continue to respond fairly strongly to expanding seasonal demand, building, electric power output, commercial borrowing, and general trade have turned unseasonably. After the promising check to falling commodity prices in August, they have again weakened, as the Federal Reserve has relaxed its open market pressure toward credit expansion.—*The Business Week,* Sept. 10.

Franco-Spanish Combine Gets Tangier Monopoly

The International Legislative Assembly of Tangier has voted a concession of a monopoly of the electric lighting and power to a Franco-Spanish combination, to the total exclusion of other proposals from foreign contractors. Although the clauses of both the constitution and the Algeciras Act are open to conflicting interpretations, the granting of so important a project without proceeding (as specified by treaty) to public tender is causing much anxiety and may become a dangerous precedent. The question of the legality of the assembly's action will be considered by the committee of control, without whose sanction the decisions of the assembly are inoperative.

Personals

J. B. BROKAW, recently chief engineer of the Eastern Oregon Light & Power Company, Baker, Ore., has resigned to accept the position of assistant manager with the Peoples West Coast Hydro-Electric Corporation, California Public Service Company and Western States Utilities Company with headquarters at Portland, Ore. Mr. Brokaw has a background of extensive practical engineering experience obtained with many utility companies.

WALTER W. GRUBER, who during the past four years has been assistant engineer in the division of dams of the Water and Power Resources Board of Pennsylvania, has been assigned to represent the board on the construction of the Safe Harbor Water Power Corporation's dam across the Susquehanna River at Safe Harbor, Pa. Previously Mr. Gruber was with the United States Engineers on the St. Lawrence waterway investigation.

DUGALD C. JACKSON, JR., for five years head of the department of mechanical and electrical engineering in the Speed Scientific School of the University of Louisville, has been appointed head of the department of electrical engineering at the University of Kansas.

EDWIN R. WRIGHT has been appointed resident engineer in charge of surveys and preliminary construction work on the Portland Canal Power Company's $3,000,000 hydro-electric project at Hyder, Alaska.

THEODORE DREIER, for the past five years an electrical engineer at the Schenectady Works of the General Electric Company, has been named assistant professor of physics at Rollins College for the coming year. He will fill a vacancy caused by the death of Dr. William S. Franklin in June.

WALTER A. BUCHANAN, district manager of the Appalachian Electric Power Company at Welch, W. Va., has been appointed chairman of the national accident prevention committee of the National Electric Light Association.

HARRY C. ROSS, for the past fifteen years division manager for the Pacific Gas and Electric Company in Fresno, Calif., has been advanced to a staff position in the operating department of the San Francisco gas division. During the past several months Mr. Ross has handled much of the distribution problem incidental to the installation of natural gas in territory served by the company. O. L. DICKINSON, for the past eleven years superintendent of the gas division of the company in Fresno will head the gas division of the San Joaquin Light & Power Corporation as a result of the recent merger of San Joaquin Power and the Pacific Gas and Electric.

Business Notes

A. M. Byers Company, Pittsburgh, Pa., has just closed its hand-puddle mill at Girard, Ohio, in anticipation of the opening of its new-process mill completed recently on the Ohio River just outside of Pittsburgh. This new mill will have an ultimate capacity of 45,000 tons of wrought iron a month, compared with the Girard plant's 5,000 tons a month.

Reliance Electric & Engineering Company, Cleveland, Ohio, announces the removal of its Boston office from 80 Federal Street to new quarters at 89 Broad St., Boston, Mass. R. H. Smith will continue as district manager of this territory.

Murray Iron Works Company, Burlington, Iowa, announces the appointment of two new selling agencies for its products: William Stairs, Son & Morrow, Ltd., Halifax, Nova Scotia, Canada, and Mathews & Company, 734 Brookhaven Drive, Orlando, Fla.

Babcock-Wilcox & Goldie McCulloch, Ltd., announce the removal of their Montreal office from St. Henry to Canada Cement Building. All correspondence should be addressed to General Post Office Box No. 3040, Montreal, Que.

Boiler Engineering Company, Newark, N. J., announces its affiliation with the Plibrico Jointless Firebrick Company of Chicago. Products of the former will now be marketed through Plibrico representatives located in over 100 cities of the United States and Canada. Boiler Engineering will continue to maintain headquarters at Newark, and the main offices of Plibrico will remain at Chicago. No changes in personnel were announced.

Babcock & Wilcox Company, New York City, announces that in addition to the appointment of Mayer & Oswald, reported in this column last week, its refractory division has added the following distributors of No. 80 products: Dreher Supply Company, 59-69 East Goodale St., Columbus, Ohio; Pioneer Service Corporation, 53 South Gay St., Baltimore, Md.; Boiler Equipment Service Company, 686 Greenwood Ave., N.E., Atlanta, Ga.; Merritt M. Stone Company, 4459 Manchester Ave., St. Louis, Mo.; James E. Degan Company, 2130-50 Franklin St., Detroit, Mich.; Windsor Cement Company, 16 Van Dyke Ave., Hartford, Conn.; C. A. Turner, Inc., 117 Third Ave., Pittsburgh, Pa.; F. H. Kingsley, 687 Davol St., Fall River, Mass., and 141 Front St., New Bedford, Mass.

Bailey Meter Company, Cleveland, Ohio, announces the opening of a branch office at 2370 Dahlia Ave., Denver, Colo. M. E. Reddick has been appointed manager of this new branch office.

Coming Conventions

American Society of Mechanical Engineers. Fall meeting at French Lick Springs, Ind., Oct. 13-17. Annual meeting in New York City, Dec. 1-5. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting at Philadelphia, Pa., Oct. 13-15. District meeting at Louisville, Ky., Nov. 19-22. Annual Winter convention in New York City, Jan. 26-30, 1931. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Welding Society. Fall meeting at the Congress Hotel, Chicago, Ill., Sept. 22-26. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Midwest Power Engineering Conference and Exhibition. Fifth meeting in Chicago, Ill., Feb. 10-13, 1931. Secretary, George E. Pfisterer, 308 West Washington St., Chicago, Ill.

National Association of Practical Refrigerating Engineers. Annual convention and exhibition at the Hotel Peabody, Memphis, Tenn., Nov. 11-14. Secretary, Edward H. Fox, 5707 West Lake St., Chicago, Ill.

National Power Show. Grand Central Palace, New York City, Dec. 1-6. Manager, Charles F. Roth, Grand Central Palace, New York City.

New England Water Works Association. Annual convention at Atlantic City, N. J., Sept. 23-26. Secretary, Frank J. Gifford, 715 Tremont Temple, Boston, Mass.

Society of Industrial Engineers. Seventeenth national convention at the Mayflower Hotel, Washington, D. C., Oct. 15-17. Secretary, George C. Dent, 205 West Wacker Drive, Chicago, Ill.

Trade Catalogs

Lubrication—Details and applications of the Farval centralized system of lubrication are described and illustrated in a new bulletin of Lubrication Devices, Incorporated, Battle Creek, Mich.

Conveyor Drives—Book No. 1191, covering a complete line of screw conveyor drives, has just been published by H. W. Caldwell & Son Company, 2410 West 18th St., Chicago, Ill. The 32 pages of this booklet are devoted to illustrations of the equipment and engineering data enabling one to select the most efficient and economical drive for the individual purpose.

Pumps—"Warren Pumps and the Organization Behind" is the title of a little 19-page illustrated booklet recently issued by the Warren Steam Pump Company, Warren, Mass., which contains in condensed form a few facts about pumps and the company.

Motors—Bulletin No. 107 of the Reliance Electric & Engineering Company, Ivanhoe Road, Cleveland, Ohio, describes and illustrates fully-enclosed, fan-cooled induction motors with ball bearings for two- and three-phase circuits.

Feed-Water Heaters—Full details of the Patterson-Berryman and Standard feed-water heaters are presented in a 12-page illustrated booklet recently issued by the Patterson-Kelley Company, 101 Park Ave., New York City.

Water Treatment—"Scientific Water Correction," a 95-page, illustrated, cloth-bound book recently issued by the Dearborn Chemical Company, 310 South Michigan Ave., Chicago, Ill., gives much valuable data on the subject.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Navy Standard	New York	$2.10 @$2.30
Kanawha	Cincinnati	1.10 @ 1.35
Smokeless	Cincinnati	1.75 @ 2.00
Smokeless	Chicago	2.00 @ 2.25
West Kentucky	Louisville	.85 @ 1.25
Steam	Pittsburgh	1.50 @ 1.60
Gas Slack	Pittsburgh	.90 @ 1.10
Big Seam	Birmingham	1.60 @ 1.75

Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.00
Barley	New York	1.15 @ 1.50

FUEL OIL

New York—Sept. 4, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c.@5.25c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c.@6.25c. per gal.

St. Louis—Aug. 27, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.345 per bbl., or 42 gal.; 26@28 deg., $1.420 per bbl.; 28@30 deg., $1.520 per bbl.; 30@32 deg. $1.620 per bbl.; 32@36 deg., gas oil, 3.901c. per gal.; 38@40 deg., distillate, 4.526c. per gal.

Pittsburgh—Aug. 29, f.o.b. local refinery, 34@36 deg., fuel oil, 3.125c. per gal.; 36@40 deg., 3.25c.

Philadelphia—Sept. 2, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati—Sept. 2, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Aug. 29, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., $0.90 per bbl.

Boston—Sept. 2, tank-car lots, f.o.b., 12@14 deg., Baumé, 3.33c. per gal.; 28@32 deg., 5c. per gal.

Dallas—Aug. 30, f.o.b. local refinery 26@30 deg., $1.10 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Siloam Springs — J. W. Sloan, Tulsa, Okla., awarded contract for earth work and concrete work for hydro-electric power plant and dam, 36 ft. high and 300 ft. long, 20 ft. waterfall on Illinois River here. Estimated cost $200,000. V. Cochrane, Wright Bldg., Tulsa, Okla., is engineer.

Ark., Nashville—Southwestern Gas & Electric Co., Texarkana, Ark., awarded contract for waterworks system, including artificial lake, dam, purification plant, etc. ,to L. E. Myers Co., Allen Bldg., Dallas, Tex.

Calif., Los Angeles — Corday & Broder, awarded contract for the construction of a 13 story medical building at Vermont and Delongpre Aves., to Corday Construction Co., 618 South Western Ave. Estimated cost $750,000. Steam heating system, three elevators, etc. will be installed.

Calif., San Francisco—City and County defeated bond election of Aug. 26 for purchase of local distribution system of Pacific Gas & Electric Co., $44,600,000; purchase of distribution system of Great Western Power Co., $18,945,000; connections and substations $3,525,000; financing construction of Red Mountain Bar power plant, $1,045,000. Also plans an election soon to vote $4,000,000 bonds for airport developments to include administration building, hangars, pumps and drainage, etc.

Calif., Torrance—Municipal Improvement District No. 1, plans an election soon to vote $400,000 bonds for the construction of waterworks and distribution systems including wells, pumps, mains, etc.

Ga., Macon—Macon Gas Co., awarded contract for the construction of four sub-stations to W. A. Stillwell & Sons. Estimated cost $60,000.

Mass., Lynn—City awarded contract for the construction of a police station, garage and boiler house to E. C. Blanchard, 333 Union St. Estimated cost $200,000.

Ill., Chicago — A. W. Swayne, 520 North Michigan Ave., had plans prepared for a 22 story, 100 x 106 ft. apartment building at 418 Belmont Ave. Estimated cost $2,000,000. McNally & Quinn, 10 South La Salle St., are architects.

Kan., Holton—City is having plans prepared for addition to power plant. Estimated cost $65,000. Black & Veatch, 700 Mutual Bldg., Kansas City, Mo., are engineers.

Mass., Boston—Park Sq. Real Estate Trust, W. J. McDonald, 260 Tremont St., awarded contract for a 40 story office building at Stuart and Berkley St ,and St. James Ave., also 20 story professional arts building at Dartmouth St., Stuart St. and Trinity Pl. to H. K. Ferguson Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $20,000,000 and $5,000,000 respectively.

Mass., Natick—J. A. Hill, 90 Pond St., is having plans prepared for the construction of an artificial ice plant on West Central St. Estimated cost $75,000. C. Coneby Engineering & Construction Co., 1580 Ansol Rd., Cleveland, O., are engineers.

Mass., Waltham—Edison Electric Illuminating Co., 39 Boylston St., Boston, plans addition and alterations to electric sub-station on Pine St. here. Estimated cost $50,000. Architect not selected.

Mich., Detroit—Bd. of Water Commissioners, L. P. Fisher, Pres., 735 Randolph St., will receive bids until Sept. 16, for sub-structure of power plant to include turbine house, switch house, and one foundation wall of boiler house. G. H. Fenkell, is chief engineer.

Mont., Great Falls—City is having plans prepared for waterworks system including filter plant and pumping station, etc. Estimated cost $200,000. Black & Veatch, 700 Mutual Bldg., Kansas City, Mo., are engineers.

Mo., Independence—City, c/o J. Craig, Clk., is having plans prepared for the construction of a 41 x 50 ft. boiler plant. Black & Veatch, Mutual Bldg., Kansas City, are engineers. Contract let for equipment.

Neb., Omaha—Metropolitan Utilities Dist., 18th and Harney Sts., plans the construction of a pumping station including equipment at Bedford Ave. and Fontenelle St. C. D. Robinson, c/o owner, is engineer.

N. J., Orange—Public Service Electric & Gas Co., 80 Park Pl., Newark, awarded contract for a 2 story, 90 x 100 ft. distribution plant at Lakeside Ave. and High St. here to United Engineers & Constructors Inc., 80 Park Pl., Newark. Estimated cost $150,000.

N. Y., Buffalo—Buffalo Terminal Co., c/o G. I. Rider Co., Marshall Bldg., Cleveland, O., Archt., awarded contract for a 1 and 2 story, 420 x 1000 ft. terminal building including refrigeration warehouses, etc. to John W. Cowper Co., Rand Bldg., Buffalo. Estimated cost $1,000,000.

O., Marietta—City is having plans prepared for the construction of a power plant. Burns & McDonnell Engineering Co., 400 Interstate Bldg., Kansas City, Mo., are engineers.

Ore., Grants Pass—City voted $400,000 bonds for waterworks improvements including filtration and pumping plant. Baar & Cunningham, Spalding Bldg., Portland, are engineers.

Okla., Watts—Illinois Development Co., Siloam Springs, Ark., awarded contract for the construction of a hydro electric plant on Illinois River near here to Southwest L. E. Myers Co., Dallas, Tex. Estimated cost $240,000.

Pa., Coraopolis Heights—Felecian Sisters, will soon receive bids for the construction of a group of buildings including power house, etc. Estimated cost $1,000,000. A. Pyzdrowski, 3410 Fleetwood St., Pittsburgh, is engineer.

Ont., Toronto—Toronto Hydro-Electric System, 225 Yonge St., plans the construction of an office building and administration building to include steam heating system, elevators, etc. Estimated cost $1,000,000. P. E. Hart, 225 Yonge St., is chief engineer.

Equipment Wanted

Boiler and Oil Burning Equipment—Kearny, N. J.—Bd. of Chosen Freeholders, Court House, Jersey City, will receive bids until Sept. 11 for furnishing and installing new boiler and oil burning equipment at Hudson County Police Headquarters, Newark Turnpike here.

Generator, Transformers, Switchboard, Etc.—Wyoming — Bureau of Reclamation, Denver, Colo., will receive bids until Sept .23, for one 5,000 kva. a.c. generator three or four 1,667 kva. 2,300 to 19,100/33,000 Y v. transformers, two gang operated disconnecting switches and one switchboard and auxiliary apparatus for Shoshone power plant, Shoshone project, here.

Generating Units, Pumps, Etc.—Morgan City, La.—M. E. Norman, Mayor and City Council, will receive bids until Sept. 16, for two 400 kw. oil engine generating units complete with accessories; two 1,000 g.p.m. Underwriter motor driven pumps, two 350 g.p.m. domestic service motor driven pumps, one 1,000 and one 3,000 g.p.m. low head motor driven pumps, switchboard, etc. for proposed improvements to waterworks and electric power plant.

Mechanical Equipment—San Fnacisco, Calif.—Bd. of Regents, University of California, Berkeley, will receive bids until Oct. 17 for mechanical equipment for central heating plant here.

Pump—Pauls Valley, Okla.—City plans to purchase a 1,500 g.p.m. engine driven standby fire pump for waterworks.

Pumps—Washington, D. C.—A. L. Flint, General Purchasing Officer of the Panama Canal, will receive bids until Sept. 19 for pumps, etc.

Pumps—Monroe, La.—City Council, will receive bids until Sept. 16 for two 350 g.p.m. domestic service motor driven pumps, one 1000 and one 3000 g.p.m. low head motor driven pumps, etc. for proposed waterworks.

Pumps — Worcester, Mass. — City plans to purchase three 21 m.g.p.d. pumps for proposed waterworks system. Estimated cost $400,000.

Pumps, Motors, etc.—Carleton, Neb.—City, H. B. Wittenberger, Clk., will receive bids until Sept. 18 for 80 g.p.m. single stroke pump, 80 g.p.m. double stroke pump, 80 g.p.m. deep well turbine pump and motor, one 10 and 15 hp., 3 ph., 220 v., 1,200 r.p.m., 60 cycle automatic start motors, etc., for proposed waterworks.

Pumps, Motors, Transformers, Switchboards, Etc. — Trenton, N. J. — City Commission, will receive bids until Sept. 19, for two 20 m.g.p.d. DeLaval centrifugal pumps driven by 675 hp., 900 r.p.m. synchronous motors, 220 kw. 1,200 r.p.m. rotary converter with switchboards and transformers, 4150 v., 4 ph., 60 cycle, a.c. switchboard; 25 kva. 4150 to 110 and 220 v. single ph. transformer at Calhoun Street pumping station.

Transformers—Los Angeles, Calif.—City, T. Oughton, Purch. Agt., will receive bids until Sept. 17 for three 3333 kva. transformers.

Industrial Projects

Calif., Los Angeles—Consolidated Steel Corp., 1200 North Main St., plans the construction of a manufacturing plant including power house, structural shop, warehouse, maintenance and rivet making building, garage, blacksmith shop, etc. at Slauson and Eastern Aves. Estimated cost $100,000. Private plans.

Calif., Salinas — American Rubber Products Inc., Matson Bldg., San Francisco, awarded contract for the construction of a 1 story, 100 x 102 ft. rubber products manufacturing plant here to E. F. Reese, 158 Central Ave., Salinas. Estimated cost $150,000.

Calif., Taft — San Joaquin Light & Power Corp., Fresno, awarded contract for a 24 x 125 ft. warehouse, including traveling crane and loading facilities to R. McGray, Taft, $13,300.

Idaho, Nampa—Pacific Fruit Express Co., is receiving bids for remodeling present plant and extension to boiler room, 14 x 22 x 15 ft. Estimated cost $25,000.

Ill., Belleville—Baker-Nagle Co., 913 Freeburg Ave., awarded contract for a 1 story, 95 x 135 ft. addition to stove plant, to Bauer Bros. Construction Co., 424 Lebanon St. Estimated cost $40,000.

Ill., Chicago—Albright-Nell Co., 5315 South Western Ave., awarded masonry and carpentry contracts for a 1 story, 140 x 200 ft. addition to factory for the manufacture of meat packing house machinery. Estimated cost $55,000.

Ill., Chicago—American Can Co., 104 South Michigan Ave., awarded masonry and carpentry contracts for a 1 story, 58 x 94 ft. boiler room and addition to warehouse at 5947-6007 South Western Ave. Estimated cost $120,000.

Mass., Everett (Boston P. O.)—New England Fuel & Transportation Co., 250 Stuart St., Boston, awarded contract for a 1 story coke station and switch house on Rover St., here, to Koppers Construction Co., Koppers Bldg., Pittsburgh, Pa. Estimated cost $40,000.

Mass., Fitchburg—Simonds Saw & Steel Co., 55 North St., plans the construction of a 360 x 550 ft. manufacturing plant. Estimated cost $1,000,000. John O. DeWolf, 45 Bromfield St., Boston, is engineer.

Miss., Corinth — Corinth Hosiery Mills, awarded contract for the construction of a hosiery mill including boiler house to H. A. McGuire & Co., Dermon Bldg., Memphis, Tenn. $92,965.

Neb., Omaha—Quaker Petroleum Co., 14th and Nicholas Sts., awarded contract for a 1 and 2 story, 56 x 210 and 60 x 96 ft. oil compounding and barreling plant at 20th and Hickory Sts., to Parsons Construction Co., Grain Exchange Bldg. Estimated cost $50,000.

N. J., Hoboken—Cornell & Underhill, 311 Spring St., New York, N. Y., awarded contract for a 2 story plant for the manufacture of iron pipe at 14th and Madison Sts. to Bonanno Bros., 1527 Bergen Turnpike, North Bergen. Estimated cost $40,000.

O., Cleveland—Cleveland Wire Works of General Electric Co., c/o E. G. Edwards, Mgr., Nela Park, is having plans prepared for a 1 story, 32 x 370 ft. factory and power house on Chardon Rd. Estimated cost $400,000. Private plans.

Pa., Uniontown—Richmond Radiator Co., 1480 Broadway, New York, N. Y., awarded contract for the construction of a group of buildings including 1 story, 50 x 160 ft. warehouse, 2 story, 32 x 56 ft. gas boiler plant, 1 story, 22 x 48 ft. addition to machine shop and 1 story, 16 x 48 ft. blacksmith shop here to Hankins Paulson Co., 108 North Beeson St.

Tex., Taylor—T. L. Rowsy and E. L. Chapman, plan the construction of a 30 x 75 ft. refinery, 20 x 75 ft. office, four bubble towers, eight condensers, pumping plant, etc. Estimated cost $200,000.

Wis., Milwaukee—Nordberg Mfg. Co., Oklahoma Ave. and Chicago Blvd., awarded contract for the construction of a 1 story, 85 x 87 ft. addition to factory to Bentley Bros. Inc., 808 South Pierce St. Estimated cost $42,000.

Ont., Brockville — E. F. Phillips Electrical Works, Ltd., 12 Mercer St., Toronto, plans 1 and 2 story additions to wire manufacturing plant here. Estimated cost $200,000. J. M. Miller, 648 Dorchester St., Montreal, Que., is architect.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

BOTH black and galvanized conduit are higher in price than at this time last month. Re-adjustments also have been effected in elbows and couplings. Conduit prices shown here are for delivery to job from warehouse stocks, mill shipments of 10,000 lb. or over taking a reduction from these quotations amounting to approximately 8 per cent. Orders for electrical goods, while around 18 per cent under last year's volume, compare favorably with sales in 1925 to 1928. Babbitt metal rose during August on all grades except manganese, or anti-friction metal for general service. Declines of the month affected rubber-covered copper wire, small-size attachment plugs, fuse plugs, second-grade belt lacing, linseed oil, structural and tank rivets.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket, net, per ft	$0.60
Common, 2½-in., cotton, rubber-lined, 80c. per ft., list, less	50%

Air—Best Grade, Net

¾-in., per ft	3-ply	$0.30	4 ply	$0.36

Steam—Discounts from List

First grade	40%	Second grade	45%	Third grade	50-10%

RUBBER BELTING—List price, 6-in., 6 ply, $1.83 per lin.ft. The following discounts from New York warehouse list apply to rubber transmission belting in quantities of about ½ doz. rolls:

Best grade	50%	Second grade	60%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses in quantities of about ½ doz. rolls:

Grade	Discount from list
Medium	30-10%
Heavy	30%

RAWHIDE LACING—Cut lacing, best quality, 40%; 2nd quality, 50-5%. Lace leather sides, best, 12-17 sq.ft., 54c. per sq.ft.; 2nd, 46c., net. Giant or Indian tanned cut lacing, 40%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts from list at New York warehouses are as follows:

85% magnesia, high pressure		40 %
Asbestos, air cell, for low-pressure heating and return lines	4-ply	65 %
	3-ply	67½%
	2-ply	70 %

PORTLAND CEMENT—New York, $2.10 per bbl., without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.10 per 100 lb. in lots of 400 to 3,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	13.00	16.00	15.00
Colored	9.50	12.00	12.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed white wipers, as follows:

Chicago (100 lb. bales)	$0.16
New York (100 lb. bales)	.13½
Cleveland (per thousand)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Minneapolis	Chicago
Per pound	$0.122	$0.136	$0.131

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b., New York:

	Dry	In Oil
Red	$13.75	$15.25
White	13.75	13.75

RIVETS—The following quotations apply on fair-sized orders from warehouse:

Tank rivets, ⅞-in. diameter and smaller, list (Apr. 1, 1927) less 65% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., round head, per 100 lb.:

New York	$4.50*
Chicago	4.00
Pittsburgh mill	2.75

*This price is for full kegs; broken kegs are $6.00 per 100 lb.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome ore, ground, 40@50%, Cr_2O_3, in bulk	per net ton	22@25
Chrome ore, ground, 40@50%, Cr_2O_3, in sacks	per net ton	26@29
Chrome ore, crude, 40@50%, Cr_2O_3	per net ton	18.00@22.50
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa	per M	43.00
Clay brick, 1st quality, 9-in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Colorado	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38

BABBITT METAL—Delivered in case lots from New York warehouse, on orders of 100 lb. or over, cents per pound:

Genuine, highest grade	50.00
Commercial genuine, intermediate grade	37.00
Anti-friction metal, general service	31.00
No. 4 babbitt, f. o. b.	10.50

COLD-FINISHED STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.65	$3.35
Flat or square	3.90	4.15	3.85

BOILER FITTINGS—F.o.b. warehouse, Jersey City, N. J., discounts from list:

Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following basing discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

	Steel			Iron	
Inches	Black	Galv.	Inches	Black	Galv.
1 to 3	64%	52½%	1 and 1¼	31%	15%

LAP WELD

2	57%	45½%	2	23%	9%
2½ to 6	61%	49½%	2½ to 3½	28%	13%
7 and 8	58%	45½%	4 to 6	30%	17%
9 and 10	55%	43½%	7 and 8	29%	16%
11 and 12	55%	42½%	9 to 12	26%	11%

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	62%	51½%	1 to 2	34%	18%
2 to 3	63%	52½%			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	55%	44½%	2	29%	13%
2½ to 4	59%	48½%	2½ to 4	34%	20%
4½ to 6	58%	47½%	4½ to 6	33%	19%
7 and 8	54%	41½%	7 and 8	31%	17%
9 and 10	47%	34½%	9 to 12	21%	8%
11 and 12	46%	33½%			

BOILER TUBES—Standard gage, manufactured in accordance with the specifications and requirements of the American Society of Mechanical Engineers and in compliance with the rules and regulations of the U. S. Steamboat Inspection Service, from New York warehouse stock, per 100 ft.:

Size, Inches*	B.W.G.	Toncan Seamless Iron	Knobbled Charcoal Iron	Seamless Steel	Lapwelded Steel
1	13	$34.00	.....	$18.00	.....
1¼	13	37.75	.....	20.25	.....
1½	13	38.00	$38.00	19.25	.....
1¾	13	30.00	30.00	22.00	.....
2	13	26.25	26.25	20.25	$19.00
2¼	13	34.50	34.50	23.00	25.00
2½	12	34.00	34.00	26.00	24.25
2¾	12	40.50	40.50	28.50	27.50
3	12	42.50	42.50	27.00	25.50
3¼	11	50.25	50.25	30.75	28.75
3½	11	54.50	54.50	33.25	31.50
4	10	67.00	67.00	40.00	38.00

These prices are based on stock lengths. If cut to special lengths billing will be based on the entire stock lengths. In addition to the foregoing, standard cutting charges are as follows:

2-in. and smaller.. $0.05 per cut
2¼ and 2½ in..... .06 per cut
3-in..... $0.09 per cut
3½ to 4 in.. .10 per cut
*External diameter.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft., New-Style, A.B.C., with fibre bushing:

B. & S. Size	BX Two Cond. M. Ft.	BX Three Cond. M. Ft.	Lead Two Cond. M. Ft.	Lead Three Cond. M. Ft.
No. 14 solid....	$25.00	$40.00	$71.00	$95.00
No. 12 solid....	41.00	52.00	82.00	110.00
No. 10 solid....	57.00	72.00	99.00	131.00
No. 8 stranded..	87.00	115.00	140.00	199.00
No. 6 stranded..	120.00	163.00	185.00	250.00

Coils to 1000 ft., +10%; less than coil lots, +20%.

CONDUIT—Rigid iron, price per 1,000 ft.; **ELBOWS AND COUPLINGS,** per 100 pieces, extra. Delivered from New York warehouse. Discount of 5 per cent for payment in 10 days; 30 days net.

Size, Inches	GALVANIZED Conduit	GALVANIZED Elbows	GALVANIZED Couplings	BLACK Conduit	BLACK Elbows	BLACK Couplings
½	$60.89	$8.31	$4.79	$55.67	$7.14	$4.36
¾	77.61	10.94	6.85	70.53	9.41	6.24
1	111.26	16.35	8.94	100.80	14.07	8.14
1¼	150.53	22.47	12.59	136.38	19.71	11.54
1½	180.00	30.05	15.59	163.08	26.35	14.29
2	242.20	54.69	20.87	219.43	47.92	19.15
2½	382.95	90.49	29.81	346.95	79.41	27.34
3	500.80	233.74	44.70	453.72	204.21	41.01
3½	630.74	511.83	59.92	574.14	446.60	55.00
4	769.61	591.84	74.69	702.53	516.46	68.53
4½	896.51	892.12	111.40	818.37	777.99	102.16
5	1045.06	1240.73	122.91	953.99	1082.29	112.75
6	1355.64	1547.71	177.72	1237.49	1350.80	162.95

CONDUIT BODIES AND FITTINGS—Black or galvanized:

	Less Than $15 List	$15 List to $100	$100 List and Over
Standard package	15%	20%	28%
Less than standard package	10%	15%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$15.00
No. 16 cotton reinforced heavy		19.00
No. 18 cotton reinforced light		12.00
No. 16 cotton reinforced light		14.00
No. 18 cotton Canvasite cord		13.00
No. 16 cotton Canvasite cord		15.00
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$64.00	*71.00
No. 14 super service cord or similar (2 wire) in 1,000 ft.	92.00	*101.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List Each
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 65%; standard package, 68%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30-amp.	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp.	.15 ea.	.15	25	50
225 to 400-amp.	.30 ea.	.30	25	25
450 to 600-amp.	.60 ea.	.60	10	10

Discount Without Contract—Fuses:
Broken cartons..... Net list
Unbroken cartons..... 17%
Ten unbroken cartons..... 34%
Discount Without Contract—Renewals:
Broken cartons..... Net list
Unbroken cartons..... 17%
Ten unbroken cartons..... 34%
Discount With Contract—Fuses:
Broken cartons..... 5%
Unbroken cartons..... 20%
Ten unbroken cartons..... 36%
Discount With Contract—Renewals:
Broken cartons..... Net list
Ten unbroken cartons..... 36%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package (500), per 100	$2.60
0–30 ampere, less than standard package, per 100	2.90

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt Watts	General Type	Price Each	200—260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.20	...	....	.....
60	A 21	.20	...	....	.....
100	A 23	.35	...	....	.....

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.06

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f.o.b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$5.20	$7.00	$7.60	$13.60
12	7.15	8.90	9.90	17.50
10	9.70	11.50	12.85	23.00
8	14.25	16.90	18.50	33.00
6	.....	.....	25.75	.....
4	.....	.....	38.00	.....
2	.....	.....	53.00	.....
1	.....	.....	80.00	.....
0	.....	.....	93.00	.....
00	.....	.....	110.00	.....
000	.....	.....	131.00	.....
0000	.....	.....	162.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap Key	½ In. or Pendant Cap Keyless	½ In. or Pendant Cap Pull	¾ In. Cap Key	¾ In. Cap Keyless	¾ In. Cap Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., in less than 100 lb., 30c. per lb.; in 100 lb. lots, 28c. per lb.
Rubber tape, ¾ in., in less than 100 lb., 32c. per lb.; in 100 lb. lots, 29c. per lb.
Wire solder, in less than 100 lb., 30c. per lb.; in 100 lb. lots, 28c. per lb.
Soldering paste, 2 oz. cans..... $1.10 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.:

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$3.50	$5.70	$9.00
60	9.00	11.00	14.00
100	14.00	17.00	29.00
200	22.00	29.00	48.00

Discounts:
Standard package..... 40%
Less than standard package..... 35%